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THE MODERN TELESCOPE.

By J. NORMAN LOCKYER.

THE gain to astronomy from the discovery of the telescope has been twofold. We have first, the gain to physical astronomy from the magnification of objects, and secondly, the gain to astronomy of position from the magnification, so to speak, of *space*, which enables minute portions of it to be most accurately quantified.

Looking back, nothing is more curious in the history of astronomy than the rooted objection which Hevel and others showed to apply the telescope to the pointers and pinnules of the instruments used in their day; but doubtless we must look for the explanation of this not only in the accuracy to which observers had attained by the old method, but in the rude nature of the telescope itself in the early times, before the introduction of the micrometer; the modern accuracy has been arrived at step by step. Let us see what the telescope does for us in the domain of that grand physical astronomy which deals with the number and appearances of the various bodies which people space.

Let us, to begin with, try to see how the telescope helps us in the matter of observations of the sun. The sun is about 90,000,000 of miles away; suppose, therefore, by means of a telescope reflecting, or refracting, whichever we like, we use an eyepiece which will magnify say 900 times, we obviously bring the sun within 100,000 miles of us; that is to say, by means of this telescope, we can observe the sun with the naked eye as if it were within 100,000 miles of us. One may say, this is something, but not too much; it is only about half as far as the moon is from us. But when we recollect the enormous size of the sun, and that if the centre of the sun occupied the centre of our earth the circumference of the sun would extend considerably beyond the orbit of the moon, then one must acknowledge we have done something to bring the sun within half the distance of the moon. Suppose for looking at the moon we use on a telescope a power of 1,000, that is a power which magnifies 1,000 times, we shall bring the moon within 240 miles of us, and we shall be able to see the moon with a telescope of that magnifying power pretty much as if the moon were situated somewhere in Lancashire—Lancaster being about 240 miles from London.

It might appear at first sight possible in the case of all bodies to magnify the image formed by the object-glass to an unlimited extent by using a sufficiently powerful eye-piece. This, however, is not the case, for as an object is magnified it is spread over a larger portion of the retina than before; the brightness, therefore, becomes diminished as the area increases, and this takes place at a rate equal to the square of the increase in diameter. If, therefore, we require an object to be largely magnified we must produce an image sufficiently bright to bear such magnification; this means that we must use an object-glass or speculum of large diameter. Again, in observing a very faint object, such as a nebula or comet, we cannot, by decreasing the power of the eye-piece, increase the brightness to an unlimited extent; for as the power decreases, the focal length of the eye-piece also increases, and the eye-piece has to be larger, the emergent pencil is then larger than the pupil of the eye, and consequently a portion of the rays of the cone from each point of the object is wasted.

We get an immense gain to physical astronomy by the revelations of the fainter objects which, without the telescope, would have remained invisible to us; but, as we know, as each large telescope has exceeded preceding ones in illuminating power, the former bounds of the visible creation having been gradually extended, though even now we cannot be said to have got beyond certain small limits, for there are others beyond the region which the most powerful telescope reveals to us; though we have got only into the surface we have increased the 3,000 or 6,000 stars visible to the naked eye to something like twenty millions. This space-penetrating power of the telescope, as it is called, depends on the principle that whenever the image formed on the retina is less than sufficient to appear of an appreciable size the light is apparently spread out by a purely physiological action until the image, say of a star, appears of an appreciable diameter, and the effect on the retina of such small points of light is simply proportionate to the amount of light received, whether the eye be assisted by the telescope or not; the stars always, except when sufficiently bright to form diffraction rings, appearing of the same size. It therefore happens that as the apertures of telescopes increase, and with them the amount of light (the eye-pieces being sufficiently powerful to cause all the light to enter the eye), smaller and smaller stars become visible, while the larger stars appear to get brighter and brighter without increasing in size, the image of the brightest star with the highest power, if we neglect rays and diffraction rings, being really much smaller than the apparent size due to physiological effects, and of this latter size every star must appear.

FIG. 1.—A PORTION OF THE CONSTELLATION GEMINI SEEN WITH THE NAKED EYE.

FIG. 2.—THE SAME REGION, AS SEEN THROUGH A LARGE TELESCOPE.

The accompanying woodcuts of a region in the constellation of Gemini as seen with the naked eye and with a powerful telescope will give a better idea than mere language can do of the effect of this so-called space-penetrating power.

With nebulæ and comets matters are different, for these, even with small telescopes and low powers, often occupy an appreciable space on the retina. On increasing the aperture we must also increase the eye-piece, in order that the more divergent cones of light from each point of the image shall enter the pupil, and therefore increase the area on the retina, over which the increased amount of light, due to greater aperture, is spread; the brightness, therefore, not increased, unless indeed we were at the first using an unnecessary high power. On the other hand, if we lengthen the focus of the object-glass and increase its aperture, the divergence of the cones of light is not increased, and the eye-piece need not be altered, but the image at the focus of the object-glass is increased in size by the increase of focal length, and the image on the retina also increases as in the last case. We may therefore conclude that no comet or nebula of appreciable diameter, as seen through a telescope having an eye-piece of just such a focal length as to admit all the rays to the eye, can be made brighter by any increase of power, although it may easily be made to appear larger.

Very beautiful drawings of the nebula of Orion and of other nebulæ, as seen by Lord Rosse in his 6-foot reflector, and by the American astronomers with their 26-inch refractor, have been given to the world.

The magnificent nebula of Orion is scarcely visible to the naked eye; one can just see it glimmering on a fine night; but when a powerful telescope is used, it is by far the most glorious object of its class in the northern hemisphere, and surpassed only by that surrounding the variable star η Argûs in the southern. And although, of course, the beauty and vastness of this stupendous and remote object increased with the increased power of the instrument brought to bear upon it, a large aperture is not needed to render it a most impressive and awe-inspiring object to the beholder. In an ordinary 5-foot achromatic many of its details are to be seen under favorable atmospheric conditions.

These who are desirous of studying its appearance, as seen in the most powerful telescopes, are referred to the plate in Sir John Herschel's "Results of Astronomical Observations at the Cape of Good Hope," in which all its features are admirably delineated, and the positions of 150 stars which surround θ in the area occupied by the nebula laid down. In Fig. 4 it is represented in great detail, as seen with the included small stars, all of which have been mapped with reference to their positions and brightness. This, then, comes from that power of the telescope which simply makes it a sort of large eye.

We may readily measure the illuminating power of the telescope by a reference to the size of our own eye. If one takes the pupil of an ordinary eye to be something like the fifth of an inch in diameter, which in some cases is an extreme estimate, we shall find that its area would be roughly about one-thirtieth part of an inch. If we take Lord Rosse's speculum of six feet in diameter the area will be something like 4,000 inches; and if we multiply the two together we shall find, if we lose no light, we should get 120,000 times more light from Lord Rosse's telescope than we do from our unaided eye, everything supposed perfect.

Let us consider for a moment what this means; let us take a case in point. Suppose that, owing to imperfections in reflection and other matters, two-thirds of the light is lost, so that the eye receives 40,000 times the amount given by the unaided vision, then a sixth magnitude star, a star just visible to the naked eye—would have 40,000 times, more light, and it might be removed to a distance 200 times as great as it at present is, and still be visible in the field of the telescope just as it at present is to the unaided eye. Can we judge how far off the stars are that are only just visible with Lord Rosse's instrument? Light travels at the rate of 185,000 miles a second, and from the nearest star it takes some 3¼ years for light to reach us, and we shall be within bounds when we say that it will take light 300 years to reach us from many a sixth magnitude star.

But we may remove this star 200 times further away and yet see it with the telescope, so that we can probably see

FIG. 3.—ORION AND THE NEIGHBORING CONSTELLATIONS.

FIG. 4.—THE NEBULA OF ORION, REDUCED FROM LORD ROSSE'S DRAWING.

stars so far off that light takes 60,000 years to reach us, and when we gaze at the heavens at night we are viewing the stars not as they are at that moment, but as they were years or even hundreds of years ago; and when we call to our assistence the telescope, the years become thousands and tens of thousands—expressed in miles these distances become too great for the imagination to grasp; yet we actually look into this vast abyss of space and see the laws of gravitation holding good there, and calculate the orbit of one star about another.—*Nature.*

TELESCOPES FOR CALIFORNIA.

MR RICHARD S. FLOYD, one of the trustees of the "Lick Trust," on his return to California, after an extended tour of foreign travel, during which he collected all the information he could with regard to the construction of great telescopes, expressed his belief that the best telescope for the Lick Observatory would be a refractor of the largest size. The cost of a suitable instrument, with object-glass of forty inches, would not, he thinks, exceed $150,000. But, in addition to the great refractor, Mr. Floyd would have in the observatory a reflector about four feet in diameter, with both silvered glass and speculum-metal mirrors. This would cost about $20,000.

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

Article XIII.

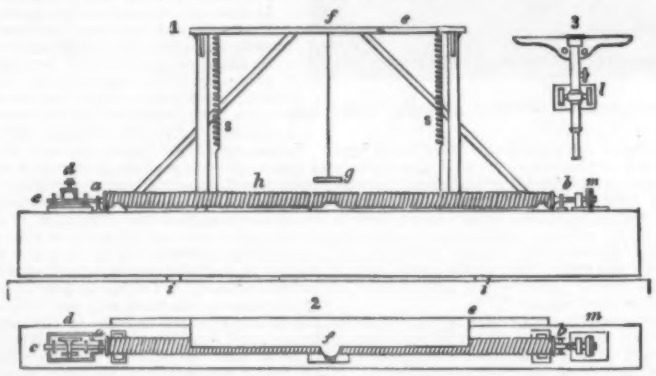
ON THE APPLICATION OF ROTATING MIRRORS TO THE MEASUREMENTS OF MINUTE LENGTHS, ANGLES, AND TIMES.

IV.—APPLICATION OF SAXTON'S MIRROR TO THE OBSERVATION AND MEASUREMENT OF THE CHANGES IN THE DIMENSIONS OF IRON AND STEEL BARS ON THEIR MAGNETIZATION.

SEVERAL years since I adapted Saxton's comparator to the experimental research on the phenomena of the elongations and retractions produced in iron and steel rods when they are magnetized. These very remarkable molecular actions of magnetism were first discovered by Joule, of England, in 1841, and the phenomena they present are so curious that I think a concise account of what Saxton's instrument revealed will be of interest.

While making these experiments the Saxton's comparator was in a cellar room, without windows, and entirely under ground. The room was only entered by a door, the bottom of which was on a level with the ceiling. During the course of the experiment the range of variation of temperature in this room did not exceed $\frac{1}{10}$th of a degree Centigrade in twenty-four hours. Six rods of different kinds of iron and three steel rods of different degrees of hardness were experimented on. These rods were 60.1 inches long and $\frac{1}{4}$ inch in diameter.

I will now describe the arrangement of Saxton's instrument which adapted it to our research. The accompanying drawings 1 and 2 give respectively an elevation and plan of the apparatus. A beam of Georgia pine, well seasoned, dried, and then coated with shellac varnish, formed the base on which the instrument was lined, and to which it was firmly attached. This beam is 7 feet long, 8¼ inches deep, and 5⅞ inches wide. At *a* and *b* are two Vs of brass, which supported the rods to be experimented on. These rods were all 60.1 inches long and $\frac{1}{4}$ inch in diameter; and each rod weighed, on the average, 1520 grams. While the ends of a rod rested in the Vs, 1100 grams of its weight was supported by the two springs, *s s*, which took hold of the rod



at distances from its ends equal to $\frac{1}{4}$ of its length. The flexure of the rod was thus in great part avoided, and it could therefore be accurately centered in the helix A. This helix is 60.25 inches long, and had an outside diameter of 1¼ inches. It is wrapped on a tube of brass of $\frac{1}{10}$ths inch internal diameter, slit throughout its whole length. At *m* is the micrometer abutting-screw, against which the end of the rod is firmly pressed by two helical springs, which are stretched between hooks on the brass mountings of the screw and a rod which passed through the terminal brass caps of the rod. The brass caps at both ends of the rod are terminated by cylinders of agate. The other end of the rod is in contact with a slide *c*, which moves accurately between guides in the direction of the axis of the rod. To this slide is attached the delicate fusee-chain, which is coiled once around the vertical axis of the mirror *d*. This chain is prevented from slipping by a steel pin, which securely attaches it to the axis. The slide, carrying the chain, is firmly pressed against the terminal agate of the rod by the tension of a helical spring. Thus the rod at one end is constantly pressed against the micrometer screw, while against the other end of the rod presses the slide which is connected with the mirror by the intervention of the fusee-chain. The well-joined framework *e* supports the springs, *s s*, and also a divided circle, *f*, from whose center dropped either a fibre of silk or a filament of glass, which supported a magnet, *g*, of very hard steel. From the oscillation of this magnet or from its deflections from the magnetic meridian by rotation of the circle, and the consequent twisting of the suspending filament, were determined the intensities of the residual magnetism of the rods. The deflections of the mirror, caused by the elongations or retractions of the rod, were observed by means of the telescope and scale, represented, at the side, at *l*. The telescope and scale were placed between five and six meters from the mirror. The latter was divided into millimeters, and each unit, given in the following experiment, corresponds to one centimeter on the scale.

This helix was a compound one, formed of four layers of copper wire. The two inner layers were formed of one length of 308 feet of .087 inch in diameter, making 1,069 turns. The two outer layers of 850 turns were formed of one piece of wire 330 feet long and .112 inch in diameter. The two helices could either be used separately or joined as one helix of 663 feet of wire in 1,919 turns.

The resistance of the inner helix was .44 ohm; the other one had a resistance of .31 ohm; together giving a resistance of .75 ohm. The latter resistance, added to that of the wire leading from the battery through a Gaugain galvanometer to the helix and back to the battery, brought up the resistance to nearly one ohm.

A battery of 25 cells of Bunsen was used, and the above interpolar resistance showed that the maximum effect of magnetism would be given by connecting the 25 cells, 5 in couple and 5 in series.

The iron and steel rods were prepared for me by Mr. William Wallace, of Ansonia, Ct. He carefully selected the material, and annealed the iron rods by packing them in a wrought iron covered box with iron scales from a rolling mill, and exposing the box to a red heat for three days; the box was then allowed to cool very slowly. The steel rods were tempered as uniformly as possible throughout their lengths. On the ends of the rods numbers were stamped, and these marks corresponded to the rods, as follows:

1—Scrap Iron.
2—Ulster Iron.
3—Norway Iron.
4—English Refined Iron.
5—Low Moor Iron.
6—Fall River Iron.
000—Steel, soft.
00—Steel, hardened and drawn to blue.
0—Steel, hardened and drawn to yellow.

Before beginning an experiment the rod was very carefully centered in the helix, and supported by the springs, which take hold of the rod at quarters of its length from its ends, and thus relieve the rod of flexure.

After the rod has been placed in the comparator with the abutting screw against one agate terminal and the mirror rod against the other, the scale reading is carefully noted, and then observed repeatedly till the reading remains stationary. Then we are sure that the heat given to the rod by the hands in placing it in the helix has dissipated, and the rod is of the temperature of the air of the room. We now, regarding the scale attentively in the telescope, pass the current through the helix. At this instant we observe a sudden movement of the scale across the thread of the telescope, indicating an elongation of the rod. The elongation, as shown by the scale reading, remains steadily the same as long as the circuit is closed and the temperature of the rod remains constant. We now break the galvanic circuit—the rod at once retracts, but this shrinkage does not equal the previous elongation, and the velocity with which the rod retracts is less than that with which it elongated.

The temperature of the rod remaining constant, it was found that the rod retained the length it had on breaking the circuit; that is, the rod has received, with its first and permanent magnet charge, a permanent elongation. On passing the current a second time the rod again elongates, but the elongation is now less than that which took place when the current was first passed around it. On now breaking the circuit the rod retracts to the length it had before the current was passed for the second time—that is, after the first magnetization and demagnetization of the rod, the successive elongations and retractions are equal. These conditions exist until four or five subsequent make and break circuits have been made; but now a change takes place in the phenomena, for on making the circuit the rod elongates about the same as in the preceding experiments, *but on breaking the circuit* the retraction does not equal the elongation; so that after each experiment the rod is slightly longer than before the preceding experiment was made. Continuing the experiment, the rod always retracts less than it elongates, and this causes the scale to appear to be pushed ahead a small quantity after each experiment. By continuing making and breaking circuit I have thus caused the whole length of the scale to pass over the cross-threads of the telescope. Now allow the rod to rest; it gradually retracts, and, after several hours have elapsed, the rod contracts to the length it had after the first current was thrown around it.

Heat developed in the rod at the instant of its demagnetization, leading to an explanation of the superiority of the armature of the Gramme magneto electric machine.—The experiments we have just described show conclusively that the minute elongations, which take place at the instant the galvanic circuit around the rod is broken, are due to the heat developed in the rod at the moment of its demagnetization.

The physical cause of the above *heating of a rod by its magnetism departing from it* has not been dwelt upon by those engaged in the construction of magneto-electric engines; and its practical importance here demands a few words of explanation. It is evident that the molecular motions in the rod which take place when it is magnetized, and cause it to elongate, are caused by the action of the electric current on the helix enveloping the rod. This case is evidently *outside* of the rod, and the molecules are forced by the helical current into the new positions, and they can only be maintained in their new positions by the continuance of the electric force. Now, as soon as the electric current ceases the molecules of the rod rush into the places they had before the current disturbed them, and this interior molecular motion, being arrested after a few oscillations, shows itself in the heating of the rod. An eminent electrician has objected to my above explanation on the ground that if the rod is heated on demagnetization it should be *cooled* on magnetization. To this I replied that the molecules were removed by a force outside of their intermolecular action—they were moved from their natural positions by the action of the current outside of the rod, and should no more be *cooled* by this action than a brick should be cooled when we lift it off the ground; and the molecules of the rod coming into their natural places, and the brick falling and striking the gronnd, are in similar conditions, and, when they come to rest, both are heated. However, if the brick had lifted itself, or the molecules had moved themselves in the rod by intermolecular repulsion, these bodies would have cooled themselves by a loss of heat equivalent to the mechanical action required to cause the rise of the brick and the motions of the molecules.

These facts explain why armatures, like those in Saxton's and Siemens' magneto-electric machines, heat very readily, by reason of their *sudden* demagnetization, while those armatures, like that of the Gramme type of machine, do not heat; for the latter have their magnetism continuously and gradually let down in intensity.

For the full illustration of the above facts I will here give a series of experiments on rod No. 2, of Ulster Iron. It is to be carefully noted that experiment 1 is that in which the current is first passed around the rod, when it is entirely free of magnetism.

No. of Expt.	Scale, Circuit open.	Scale, on Closing Circuit.	Scale on breaking circuit.	Elongation.	Retraction.
1	37.6	39.2	38.0	1.6	1.2
2	38.0	39.2	38.0	1.2	1.2
3	38.0	39.2	38.0	1.2	1.2
4	38.0	39.2	38.0	1.2	1.2
5	38.0	39.2	38.0	1.2	1.2
6	38.0	39.2	38.1	1.2	1.1
7	38.1	39.3	38.1	1.2	1.2
8	38.2	39.4	38.3	1.2	1.1
9	38.3	39.5	38.4	1.2	1.1
10	38.4	39.55	38.6	1.15	0.95
11	38.6	39.6	38.6	1.0	1.0
12	38.6	40.0	38.85	1.4	1.15
13	38.85	40.1	39.0	1.25	1.1
14	39.0	40.2	39.1	1.2	1.1
15	39.	40.2	39.2	1.1	1.0

I also found that the amount of heat given to the rod was directly as the number of break-circuits. I ascertained this by drilling a hole about 6 inches deep into the end of a rod of soft Norway iron, and inserted into this hole a thermo-electric couple, formed of two wires, one of copper, the other of iron. This compound wire was wrapped, first with two layers of waxed silk, then with twelve layers of floss silk, and over these layers I coiled two more layers of waxed floss silk, leaving, however, the point of junction of the wire exposed.

This apparatus was introduced into the rod so that the uncovered point of the wire was about one millimeter from the bottom of the hole, and the space included between the point of the wire and the bottom of the hole was filled with fine iron filings. The terminal wires of the thermo-electric couple were connected with a delicate galvanometer. With the apparatus thus arranged, I successively made 50, 100, 200, 300, and 400 break circuits, taking care that the closed circuits preceding the break-circuits should all be of the same duration.

After each series of break circuits the elongation produced in the rod and the permanent deflection in the galvanometer needles were noted, and the observations showed that the elongations of the rod and the increments of its temperature were proportional to the number of break-circuits.

An electric current of a definite strength produces the same amount of elongation in an iron rod whether this current be sent at once with its full strength around the iron rod, or be gradually increased in strength up to its maximum amount. The above fact was discovered in the following manner. I cut the wire leading from the helix to the battery and firmly fastened one of the loose ends to a support. Between this end of the wire and the opposite wall I stretched a long and fine wire of German silver. The other loose end of the battery wire was bent into a sharp angle and the vertex of this angle was well amalgamated. Now by sliding this bent copper wire along the fine German silver wire toward the other copper wire, I gradually diminished the resistance and increased the strength of current traversing the helix. When the two copper wires touched, of course we had the maximum battery current going through the helix. It was found that on bringing in contact the two ends of the cut copper wire that a certain elongation of the rod was instantly produced, and that the same amount of elongation was gradually obtained by slowly gliding the bent copper wire over the German silver wire till the two copper wires came in contact. It thus appears that a sudden passage of a strong electric current is not necessary to produce the very great mechanical action indicated by the molecular strain produced in a rod by the enveloping electric current.

If a strong current which has produced an elongation in a rod be gradually diminished till it is very feeble, the rod remains elongated till this feeble current is broken, when the rod suddenly retracts.

The above fact is shown by the following mode of experimenting. The two ends of the copper wire are brought together and the elongation of the rod noted. Then the bent end of the copper wire is slowly slid over the German silver wire. During the first part of this motion we observe the rod retract slightly; then it ceased to retract altogether and remains elongated with a current passing through the helix, which is so feeble, that, if it were suddenly through the helix, around an unmagnetized rod, it would not be able to elongate it sufficiently to be measurable.

However, on breaking this feeble current, by removing the copper from the German silver wire, the rod suddenly retracts to the length it had before the experiment. This experiment shows a new phenomenon of magnetism, similar to the set of rod when overstrained, and I have proposed the name of "magnetic set" for the phenomenon. The molecules having been forced by the action of the current into new positions, they retain them on gradually diminishing the cause of the disturbance, either from statical molecular

friction, or as we may better state it, from taking temporarily a new position of polarity.

Effects observed on making and breaking separate currents in the component helices of the compound helix.

In these experiments two batteries were used. In the outer helix I made and broke a current from 16 cells, arranged four coupled and four in series. In connection with the inner helix, I used a battery of 25 cells, connected five in a row and five in series. The experiments are interesting as showing the effects of the induced currents formed on making and breaking circuits in the different manners hown in the following experiments.

(1) Made circuit in inner helix, rod elongated 1.4 division on scale. Made circuit in outer helix, rod elongated .25 division on scale. Broke circuit in outer helix, rod retracted .25 division on scale. Broke circuit in inner helix, rod retracted 1.4 division on scale.

(2) Made circuit in outer helix, rod elongated 1.5 divisions on scale. Made circuit in inner helix, rod suddenly retracted .4 of a division on the scale and then suddenly elongated .4 division. Broke circuit in outer helix, rod retracted 1.5 divisions.

(3) Made circuit in inner helix, rod elongated 1.4 divisions. Made circuit in outer helix, rod elongated .25 division. Broke circuit in inner helix, rod suddenly retracted .35 division, then suddenly elongated .35 division. Broke circuit in outer helix, rod retracted 1.65 divisions.

(4) Made circuit in outer helix, rod elongated 1.5 divisions. Made circuit in inner helix, rod suddenly retracted .5 division, then suddenly elongated .05 division. Broke circuit in outer helix, rod retracted .1 division. Broke circuit in inner helix, rod retracted 1.4 division.

On the times occupied in the elongations and retractions of an iron rod when the two component helices are joined as one helix, and placed in the circuit of one battery. The determinations here given were made with the eye and a chronograph. The experiments given under this heading and the succeeding one, give an insight into the *velocities* of the molecular motions, and hence these determinations, taken in connection with the measures of the corresponding elongations and retractions (given in the table in the section following the next), are of considerable interest.

The following experiments were made on rod No. 3, of English refined iron; each result is the mean of 50 experiments.

	Time of elongation	Time of retraction
(1) 25 cells,	$\frac{1}{5}$ of a second.	$\frac{1}{10}$th of a second.
(2) one cell,	$\frac{1}{16}$th of second.	$\frac{1}{16}$th of a second.

It is thus seen that, with 25 cells, the duration of the retraction is six times as long as the duration of the elongation; but with a current from one cell the phenomena are reversed and the duration of the elongation is three times that of the retraction.

Determinations of the time occupied in the elongation and the retraction of an iron rod when the inner or outer helix forms in itself a closed conductor, while the current passed, in the respective cases, in the outer and in the inner helix.

(1) Terminals of inner helix *not* joined. Current passed through the outer helix from 25 cells. Elongation of the rod 1.5 divisions. Times of elongation $\frac{1}{10}$th of a second. Times of retraction, $\frac{1}{4}$ second.

(2) Same result as above when the *outer* helix was open, and the circuit passed through the inner helix.

(3) The terminals of inner helix united; so that this helix formed a closed circuit in itself. Current from 25 cells passed through outer helix. Elongation, 1.5 divisions. Time of elongation, $\frac{4}{5}$ths of a second. Time of retraction $1\frac{1}{10}$th second

(4) Same result as above when the terminals of the outer helix were united, and the current passed through inner helix.

(5) One cell used. When the terminals of the outer or inner helix were *not* united and the current passed respectively through the inner and outer helix, the elongation was 1.1 division. The time of elongation $\frac{1}{5}$th of a second.

(6) One cell used. The terminals of the inner helix united. The elongation was 1.1 division. Time of elongation, $\frac{4}{5}$ths of a second. Time of retraction 1 $\frac{1}{5}$ths of a second.

(7) Same result as experiment 6, when the terminals of the outer helix were joined, and the current from one cell passed through the inner helix,

To observe a rod slowly retracting during $1\frac{3}{5}$ths of a second was a most remarkable sight, and suggests many thoughts as to the interaction of the induced currents passing on the helices and iron rod. I may here venture to suggest that the study of these extraordinary phenomena—which I believe I first discovered—will eventually be of some service in the study of the induced currents of the inductorium and other magneto-electric instruments. For the present I present merely the *facts*.

In experiments 3 and 6 the time of retraction was respectively $1\frac{1}{5}$th and $1\frac{2}{5}$ths second, and the slowness of these motions allowed me to obtain an insight into their character. In each of the experiments the rod retracted with a gradually diminishing velocity; and the motion reminded one forcibly of that pertaining to a body projected vertically upward.

The co-efficients of elongation and of retraction of six rods of different species of iron, and of those of steel of various degrees of hardness.

In the table here given the numbers contained in column A show the character of the rod of iron or steel corresponding to the number given in the table in the beginning of the account of this investigation.

After the numbers given in tables I and III, I have written e to designate the *elongation* of the rod, and r to show its *retraction*.

The phenomena of *Elongation and Retraction* observed in rods of *Steel*.

The phenomena observed in the magnetization and demagnetization of steel have not been referred to. Here we have remarkable results presented to us. On first passing the current around rod 000 of soft steel, it elongated .8 of a scale division, behaving like a rod of soft iron; but, on breaking the circuit, to my astonishment, it *again elongated* .6 of a division, thus leaving this rod with a permanent elongation of 1.4 division; and this elongation exceeds the permanent elongation given to any of the soft iron rods when similarly experimented on

On passing the current around the rod, *for the second time*, the soft steel rod again acted differently from a rod of iron, for it *retracted* .25 of a division, instead of elongating as did the rods of iron under similar circumstances. On breaking this current the rod *elongated* .25 of a division, instead of *retracting* like iron, and thus the rod was again left with its permanent elongation of 1.4 of a division. It is here to be remembered that *all of the steel rods* behaved in the same manner on the making and breaking of the second and subsequently formed circuits.

These curious and new facts have an important bearing on the permanency of those standards of length which are made of soft steel. If by any means, by the accidental approach of a strong magnet, or by the inductive magnetic action of the earth on them, they should be magnetized, they would thereby receive a *permanent* elongation and destroy its trustworthiness as standards.

Table of the Elongations and Retractions of the Rods.

TABLE I.

Elongations and Retractions in Units of the Telescope-scale.

A. Rod.	B. 1st make-circuit.	C. 1st break-circ't.	D. Permanent e or r	E. 2d make-circuit.	F. 2d break-circuit.
1	1·25 e†	·15 r	·4 e†	·1 r†	·1 r†
2	1·6 e	1·2 r*	·4 e†	1·2 e	1·2 r
3	2·0 e	·9 r	1·1 e	1·4 e*	1·4 r*
4	2·5 e*	1·15 r	1·35 e*	1·15 e	1·15 r
5	1·65 e	·6 r†	1·05 e	1·0 e	1·0 r
6	1·4 e	·35 r	·95 e	·9 e	·9 r
000	·8 e*	·8 e*	1·4 e*	·25 r	·25 e
00	·25 r	·5 e	·25 e	·5 r*	·5 e*
0	·4 r†	·25 e†	·15 r†	·2 r†	·2 e†

TABLE II.

Elongations and Retractions in Fractions of an inch.

A.	B.	C.	D.	E.	F.
1	·0001375 inch	·0000825 inch	·000044 inch	·000077 inch	·000077 inch
2	·000176 "	·000132 "	·000044 "	·000132 "	·000132 "
3	·000220 "	·000099 "	·000121 "	·000154 "	·000154 "
4	·000275 "	·0001265 "	·0001485 "	·0001265 "	·0001265 "
5	·0001815 "	·000066 "	·0001155 "	·000110 "	·000110 "
6	·000154 "	·0000935 "	·0000605 "	·000099 "	·000099 "
000	·0001188 "	·0000816 "	·0002044 "	·0000365 "	·0000365 "
00	·0000365 "	·0000730 "	·0000365 "	·0000730 "	·0000730 "
0	·0000584 "	·0000365 "	·0000219 "	·0000292 "	·0000292 "

TABLE III.

Coefficients of Elongations and of Retractions.

A.	B.	C.	D.	E.	F.
1	·000002288 e†	·000001277 r	·000000732 e†	·000001281 e†	·000001281 r†
2	·000002928 e	·000002196 r*	·000000732 e†	·000002196 e	·000002196 r
3	·000003660 e	·000001647 r	·000003013 e	·000002562 e*	·000002562 r*
4	·000004575 e*	·000002105 r	·000002471 e*	·000002088 e	·000002088 r
5	·000003019 e	·000001098 r†	·000001921 e	·000001830 e	·000001830 r
6	·000002562 e	·000001555 r	·000001066 e	·000001647 e	·000001647 r
000	·000001943 e*	·000001457 e*	·000003400 e*	·000000607 r	·000000607 e
00	·000000607 r	·000001212 e	·000000607 e	·000001212 e*	·000001212 e*
0	·000000972 r†	·000000607 e†	·000000364 r†	·000000486 r†	·000000486 e†

* Maximum. † Minimum.

The experiments on rod 0, of hard steel "drawn to yellow" are noteworthy. On making the *first* circuit, this rod *retracted* .4 of a division, and on breaking this circuit, the rod elongated, but only by .25 of a division, thus leaving the rod permanently *retracted* .15 of a division; so that this rod of hard steel, which after the experiment remained a powerful magnet, is shorter than it was before it was magnetized. On passing the second current around this rod, it, like the two preceding rods, *retracted* .2 of a division, and on breaking this circuit, it elongated by the same quantity; so that after the second and subsequent passages of the voltaic current, it persisted in the retraction it had received when the first made circuit was broken

DENSITY OF VAPORS.

ONE of the most important of the recent additions to chemical methods is that of Victor Meyer for determining the density of the vapor of substances which have a high boiling point. As in the method of Gay-Lussac or in the modification of that method as employed by Hoffman, a given weight of the substance used is converted completely into vapor and the volume of this vapor measured under determinate conditions. An amount of the substance not exceeding seven or eight centigrams, but varying naturally with the density of the vapor to be determined, is weighed out in a small glass tube of such size and shape that it can easily be passed through the curved neck into a glass bulb holding about twenty-five cubic centimeters. The glass tube, at the end of which the bulb is blown, is bent into a U shape, and cut off so that its open mouth is on a level with a capillary opening on the top of the bulb, and the little apparatus is suspended by a wire holder so that these openings are always uppermost. The glass having been weighed to decigrams and the material introduced, the interior is filled at 100° C. with Wood's fusible alloy which melts at 70° C., the capillary opening at the top of the bulb allowing the air to escape while the melted metal is poured in through the open mouth. As soon as the bulb is filled this capillary opening is closed by a blow-pipe; and as soon as, after exposure in a steam bath, the excess of metal has overflowed, the apparatus is wiped and again weighed, but as before, only to decigrams. The apparatus is now immersed in the vapor of boiling sulphur, which, according to the experiments of Regnault, has a constant temperature of 442·2° when the barometer stands at 723·5 mm.* The substance passes into vapor and a considerable portion of the alloy overflows, and the tension of the vapor thus formed is evidently measured by the height of the barometer column at the time, plus the equivalent in mercury of the height of the column of melted metal which fills the neck of the apparatus above the level of the metal in the bulb. The last is easily measured with a millimeter scale if, at the instant of lifting the apparatus from the sulphur bath, the level of the metal is marked on the bulb, which may be easily done with melted sealing wax, using a heated glass rod as a pen. When now the apparatus has partially cooled and the adhering particles of metal have been removed, it is weighed for the third time; and from the three weights we easily ascertain what quantity of metal has overflowed in the sulphur bath. This amount is obviously a measure of the volume of the vapor formed. It is not, however, a direct measure, for the overflow is caused not only by the formation of the vapor, but also by the expansion of the alloy, while, on the other hand, it is diminished by the expansion of the glass. Before, therefore, the data thus obtained could be used in calculating the density of a vapor, it was necessary to determine the density of the alloy at the boiling point of sulphur, also the apparent expansion of the alloy in the ordinary German glass when heated from 100° to the same temperature. This Victor Meyer has done, and according to his determinations the apparent expansion of the alloy was, on the average, 0·036, and at 444° one gram had the volume of 0.1092 c. c., so that its density was about two-thirds of that of mercury. From these values he deduces the following formula for the calculation of the vapor density from such observations as we have described:

$$\text{Density (referred to air as unity)} = \frac{w\ 14146000\dagger}{W - 0{\cdot}036\ W')\ (H + \frac{1}{2}h)};$$

here w is the weight of the substance used, W' the weight of alloy which filled the bulb at 100°, and W the weight which overflowed in the sulphur bath; also H the height of the barometer and h the difference of level of the alloy in the bulb and neck of the apparatus at the moment it was withdrawn from the bath.

Wood's fusible alloy is exceedingly well adapted to the use to which it has been so beautifully applied by Victor Meyer. As prepared and sold by Dr. Schuchardt of Görlitz it appears to have a very constant composition and equally constant physical qualities. Moreover, it is but slightly acted on by boiling sulphur and can readily be recovered from the sulphur bath into which it overflows. It can then be easily cleaned and used over again repeatedly. But for these and other details we would refer to the very full description of the process which has recently appeared in Fresenius' Zeitschrift für Analytische Chemie, xvi, 482. Of course the method has a limited application and cannot be used with any substance which would act chemically upon the alloy. Still it has already very considerably extended our knowledge of the vapor densities of the less volatile organic products, and for such substances it is both more easy of application and more accurate than the only comparable method, that of Dumas as modified by Deville and Troost. We add two examples for illustrations.

Anthrachinon.

Substance used	w	= 0·0653 grm.
Metal used	W'	= 264·4 "
" which overflowed	W	= 179·6 "
Barometer height	H	= 728·5 mm.
Difference of level	h	= 33· "
Resulting density		7·22
Theory for $C_{14}H_8O_2$		7·19
Found by Gräbe with the process of Deville and Troost		7·35

Paradibrombenzol.

Substance used	w	= 0·0772 grm.
Metal used	W'	= 261·5 "
" which overflowed	W	= 187·4 "
Barometer height	H	= 728·5 mm.
Difference of level		38 "
Resulting density		8·14
Theory for $C_6H_4Br_2$		8·15

J. P. C., JR.—*Amer. Jour. Sci.*

SCIENCE NOTES.

THE French Government intends to send out an expedition to San Francisco in order to observe the next transit of Mercury, which will take place on May 6, 1878.

DEATH OF A FAMOUS GORILLA.

THE Berlin Aquarium suffered, on November 13, the loss of what was certainly, from a scientific and from a financial standpoint, the most valuable zoological specimen in Europe, viz., the famous gorilla Pongo, whose human-like form and playful antics became so familiar to Londoners during the past summer. The visit to England, and stay in its warm moist climate, was regarded as having the best effect on Pongo's health, when he returned to Berlin on September 21, and there was every prospect of the animal's being able to live through his second northern winter. Four weeks later a lessening of appetite and slight diarrhœa were observed, but were not regarded by the physician as of sufficient importance to prevent Pongo's appearance in public. The consternation was great when, a few days later, the gorilla died suddenly, without any apparent increase of dangerous symptoms. The loss to the Berlin Aquarium is no small one, as it had lately refused an offer of £2,500 for the animal, and, taken in connection with the late deaths of their orang-outang and chimpanzee, will check somewhat the tendency to invest capital in anthropoidal apes. Not less severe is the loss to the scientific public, for no animal of late years has so attracted the attention of zoölogists as Pongo, and theorists were looking forward with no slight degree of interest to the possibilities connected with his growth and education. After a dissection, which will probably reveal the cause of the sudden death, the skin will be handed over to the Berlin Anatomical Museum.

REMARKABLE GEMS.

ONE of the effects of the war in the east appears to be the discovery, in out-of-the-way towns in Russia, of gems of unsurpassed size and beauty, which doubtless have been jealously hoarded by their possessors, and only brought to light in times, like the present, of national necessity. Some of these gems have naturally found their way to England; perhaps the most remarkable are—an aquamarine, far superior to anything before seen in England, weighing over six ounces and a half, without the slightest blemish, and of a deep sea-green tint; also a topaz rivalling that purchased for the Grand Mogul at Goa for £11,260. These two remarkable gems were received from Moscow by Mr. Bryce M. Wright, Mineralogist, of Great Russell Street, the possessor of the unique suite of diamonds called the "Bryce Wright Diamonds," valued at £31,000.—*Nature*.

THE number of dyers, printers, bleachers and finishers in Germany is said to amount to 10,000.

* This is the mean height of the barometer at Zurich where Meyer's determinations were made. At the mean level of the sea with the mean height 760 mm. the boiling point is more nearly 447·7°.

† At the sea level when the barometer stands at 760 mm. this constant becomes 14216000. Either value is easily deduced.

The amount of substance taken gives at 444·2° a definite volume of vapor at a measured tension. Let that volume in cubic centimeters be represented by v and the tension in millimeters by H'. The density of the vapor is equal to its weight divided by the weight of the same volume of air at the same temperature and tension, or $d = \frac{w}{w_1}$, and, as is well known,

$$w' = 0{\cdot}001293 \frac{1}{(v(1 + 0{\cdot}003665 \cdot 444{\cdot}2)} \frac{H'}{60}.$$

But in the process we are considering, the volume of the vapor is evidently equal to the volume of the overflow at 444·2° less than that of the overflow which would have resulted from the expansion of the metal and glass alone, or $V = 0{\cdot}1092\ (W - 0{\cdot}036\ W')$ and as we have seen, $H' = H + \frac{1}{2}h$. Making now the substitutions and combining the numerical values we obtain the expression given above.

IMPROVED HYDRAULIC HOIST.

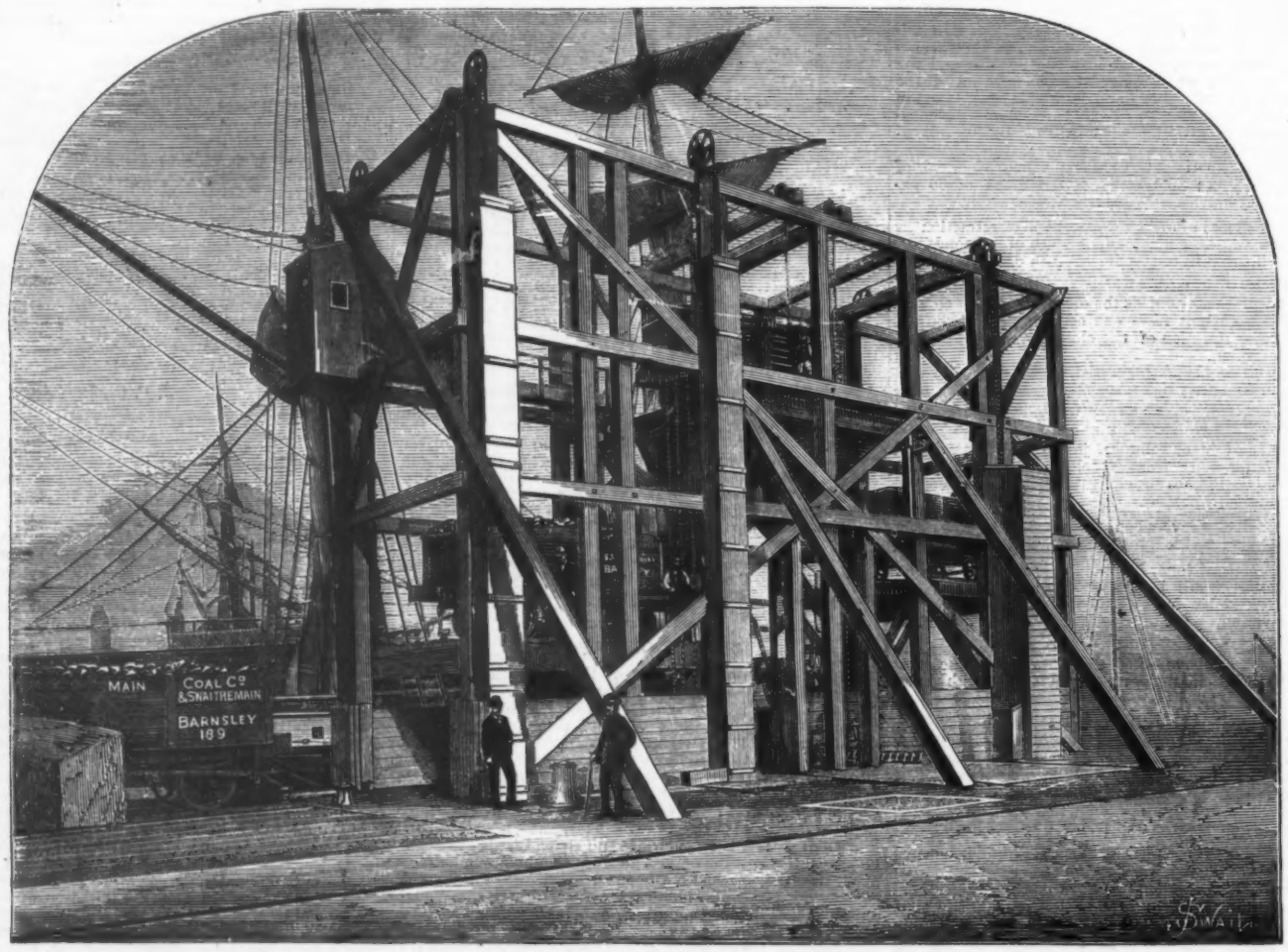
THE coal hoist we illustrate, and which has been employed for the last two years in shipping coal at the Albert Dock, Hull, is constructed on the continuous or through system—*i. e.*, the full wagons enter at the end from the sidings, are raised to the required height, their contents discharged, and then they are lowered and run into the sidings on the other side of the hoist. Turntables, which are generally required in other hoists, being unnecessary in this, their cost is avoided, and time occupied in working them is saved.

The apparatus, as will be seen on referring to our illustration, consists of a timber structure, in which are placed three platforms, two moving and one fixed, the hydraulic machinery, and the discharging spout. The moving platforms at each end are respectively used for raising the full and lowering the empty wagons. The middle platform is fixed, and carries the hopper into which the coal is discharged from the wagons. The mode of working the hoist is as follows:—The full wagons having been drawn on to the first platform, are raised to a height of 2 ft. by means of a direct-acting hydraulic ram, fixed in a well under the platform. If the wagons are hoppered they pass on to the middle platform, are there discharged, and then, being passed on to the lowering platform, descend and run into the sidings provided for the empty wagons. The rails on the three platforms being laid at an inclination, the wagons are easily moved from one to another. By means of a special arrangement in connection with the lifting platform the hoist is able to deal with end door as well as with hoppered wagons. This is accomplished by making the platform in two parts, the interior one, which carries the rails, being caused to swing on a horizontal axle, so that the wagon standing on it can be tilted to an angle sufficient to insure the coal being discharged. The power required to tilt the rails with a wagon on them is obtained from a separate hydraulic ram, which is also fixed under the lifting platform, having a chain attached to it and the after-end of the interior platform, which chain is so arranged as to allow the platform to travel up and down independently of the tipping gear. When end-door wagons have to be dealt with, after they have been raised to the required height, instead of being run over the discharging hopper, as in the case of hoppered wagons, the hind axle of the wagon is engaged by two hooked arms actuated by a treadle on the lifting platform, which treadle has in connection with it a locking apparatus for securing the tipping frame when not in use. The wagon being thus secured by the arms, the tipping frame with the wagon on it is tilted up by the means already described, and the coal is thus shot into the hopper. The frame is then allowed to return to its original position, and the hooked arms are released from the axle. At the same time the locking gear fixes the frame, and the wagon is moved forward on the lowering platform. This platform is counterbalanced, and the chief feature in connection with it is the employment of hydraulic power as a brake in lowering the empty wagons. The platform is hung on chains passing over pulleys fixed on the top of the timber framing, which are connected with and worked by a ram fixed on the outside of the framing. The empty platform is raised to the level of the hopper platform by means of the ram, which is so proportioned that the weight of the empty wagon is sufficient to cause it to descend and to force back into the pressure main the whole of the water admitted into the cylinder for lifting the empty platform, so that no expenditure of water or of power takes place in the operation of lowering the empty wagons. A capstan, worked by one of Brotherhood's patent three-cylinder hydraulic engines, is provided for drawing the full wagons on to the raising platform, and sufficient inclination is given to the rails on the lowering platform and to the line leading to the sidings to cause the empty wagons to run into them of their own accord. The valves for working the machinery of the raising platform are under the control of one man, who travels up and down on it. The coal spouts are of wrought iron of the usual construction, and adjusted by hand winches to suit the varying levels of the vessels being loaded. When the hoist is not at work the spout is drawn out of the way.

Our illustration, which is taken from a photograph, shows three wagons being operated upon at one time, a full one being raised, a second being emptied, and an empty one descending. Whilst this is going on, full wagons are being brought forward towards the hoist by the above mentioned hydraulic capstan.

With the properly hoppered wagons constructed to discharge the coal freely, this hoist is capable of shipping 300 tons per hour. The hoist has been designed and patented by Mr. R. A. Marillier, resident engineer to the Hull Dock Company, and the machinery manufactured and erected by the Hydraulic Engineering Company of Chester.

In some hoists on this plan now about to be constructed it is intended to increase the facilities for tipping end-door wagons. Before being tipped they will be brought over the middle platform, and when there can be tipped from either end. The hoist will thus be capable of dealing with the three end-door wagons at one time, as in the case of hoppered wagons, and no necessity for turning them can arise, no matter which end comes first.—*Engineer.*



IMPROVED HYDRAULIC HOIST FOR DOCKS AND OTHER PURPOSES.

THE STEAM YACHT ESTELLE.

WE recently alluded to this remarkable little steamer and a trial trip that she made at Bristol, R. I. There has been so much interest exhibited respecting her build, mold, and speed that we now give further particulars. The Estelle was constructed by the Herreshoff Manufacturing Company, of Bristol, R. I., for parties in this city. Length over all, 120 feet 9 inches, about 7 feet less at water line, with 16 feet 8 inches beam, and a depth of 8 feet molded. The vessel is provided with two light masts and has midship deck-house, plainly finished. The operating machinery consists of one Herreshoff coil boiler and a compound engine. The boiler is constructed of several sizes of gas pipe, the largest being 4 inches in diameter, coiled in the form of a truncated cone with top closed, and set in a casing lined with fire-brick, over a circular grate 6 feet 10 inches in diameter. In operation, the boiler is fed near the top, the supply being a little greater (estimated at ten per cent. greater) than was necessary to supply the desired quantity of steam. As the water descends in the coil the greater portion is vaporized, the remainder rises with the steam through a four-inch vertical pipe inside of the furnace, which is extended at the top outside of boiler and connected with a separator, consisting of a high cylindrical vessel with glass gauge at the bottom. The entrance to separator is so arranged that the current of steam and water is thrown against the sides of the vessel and the water descends in spiral lines and falls to the bottom when it is regularly blown out. The steam issues from the top of separator, and is conducted on its way to the engine through a super-heating coil of four inch pipe surrounding the main coil. The pipes are closely laid in top of main coil, and the heated gases pass between the pipe coils at the sides and, rising in the surrounding annular space, are directed by a conical cover to the central smoke-pipe. The coils have a total length of about 555 feet. There is approximately 418 square feet of heating surface in main coil, and 22 feet in super-heating coil, or 440 feet in both. A fan-blower is provided, with which fires are forced for the higher speeds.

The compound engine has cylinders respectively 12 and 21 inches in diameter, with 24 inches stroke of piston. The smaller engine works an air pump 9 inches in diameter by 8 inches stroke. The main exhaust pipe, 7 inches in diameter, runs aft through the hold to within about 8 feet of stern post, where it connects with two external condensing pipes, each 34 feet long, tapered from 5 to 2½ inches in diameter, which lead forward along the lines of the vessel and connect inside to air-pump, thus exposing 67 square feet of condensing surface. The hot well is a small horizontal cylinder in free communication with the water resulting from condensation of steam as delivered at the top. The feed-pumps also receive water near the top of hot well, thereby taking the fresh water first and salt water for any additional supply required. The screw propeller is three-bladed, 7 feet 4 inches in diameter, with 10 feet mean pitch. The projected surface is about three-tenths (3) of that of a disk of same diameter. During the trial trip under the supervision of Mr. C. E. Emery, C. E., the average steam pressure was by gauge, 67.33 pounds. Average intermediate pressure, 4.33; average vacuum, 23.96 inches; average revolutions per minute, 134.10; indicated horse, 175.023; actual speed, 13.15 knots; slip of screw (at mean pitch), 0.63 per cent.

On the first trial trip the vessel is certified by the referees appointed in behalf of the owner and builder to have run 78¼ statute miles in 7 hours and 10 minutes, with a consumption of 1722 pounds of coal. This is at the rate of 10.918 statute miles, or 8.48 knots per hour. The vessel also succeeded in attaining a maximum guaranteed speed of 14 knots per hour for three consecutive hours.

INDUSTRIAL SCHOOL OF FLERS.

THIS school, which was founded some years since, has just issued its new programme. The course of study occupies two years. The first year is devoted to the theory and practice of weaving, and includes the study of the raw material, the decomposition of tissues, the principles and details of looms of all kinds, and the steam engine, drawing and book-keeping. The second year is devoted to chemistry applied to dyeing and bleaching, including the study of coloring matters of all kinds, and the materials of bleaching; the testing of commercial products, the examination of the principal processes of dyeing wool and cotton, and bleaching. Arrangements are made for the pupils to visit certain mills, dye-houses, bleaching and dressing-houses. The charge for the first course is equal to £16, and that of the second to £12; but a pupil may follow either or both, as he may see fit; and the chemical course being given in the evening, a pupil may go through the two courses in the same year, and those of the second year are free to attend the practical course as well, if they please. Moreover, the courses delivered are revised by the professors, printed, and sold. In short, everything is done to bring the teaching within the reach of nearly all, even to the terms of payment—namely, half at the commencement of each course, and the rest in three months. We are not aware whether this and other schools of the same class admit foreign pupils.

THE DRIVE WELL IN ENGLAND.

AT a recent meeting of the Society of Engineers, London, the following paper "On Tube Wells" was read by Mr. Le Grand. It is now a little over ten years since tube wells were introduced into this country. The first notice came from America, though a contemporary claim has been made from yet another quarter of the globe. The crude idea had lain dormant for nearly two years, and might have done so for many more, had it not come into the hands of Mr. J. L. Norton, whose indomitable energy soon produced the necessary appliances to develop it into an invention of real practical utility, for which three separate patents were taken out. Public trials of its usefulness were made in London, Manchester, and elsewhere, and as Government was at that time preparing its expeditionary force for Abyssinia, the War Office authorities had their attention drawn to the invention, and with unusual alacrity they ordered trials to be made at Chatham. These trials so satisfied the commandant of the Royal Engineers that he forthwith recommended the authorities to adopt tube wells as part of the equipment of the corps of engineers, and they continue to form an integral part of such equipment to the present day.* It is needless here to recall the fact of how valuable they proved in Abyssinia, and how, as a matter of course, they were sent to Ashantee. Incidentally it may be mentioned, as showing what an interest the late Emperor of the French took in all matters of public utility, no sooner had they become known through the wide-spread publicity given to the invention by the press, that he sent over and invited Mr. Norton to bring his apparatus to St. Cloud. Mr. Norton accordingly repaired thither, and in the presence of the Emperor and the Prince Imperial drove a well. The soil proving favorable, it only occupied half an hour to drive 28 ft. deep, and to obtain a good supply of water, both the Emperor and the Prince Imperial assisting in the work. Most inventions of the present day are known by some distinctive name or appellation given to them by their respective proprietors, but this was not the case in this instance, for, by a sort of common consent, both the press and the public dubbed them "Abyssinian" tube wells, and sometimes "Abyssinian" pumps; the latter can, however, hardly be considered correct, as the invention relates almost exclusively to making wells, while pumps of various patterns are employed in the work, and all descriptions of pumps are applied to them when permanently set up. Before proceeding to describe the invention in detail, it may not be amiss to correct one or two popular errors which have even found their way into the "Government Text Book of Instruction in Military Engineering." One is, that any sort of gas, or other pipe, will answer the purpose, whereas specially tough lap-welded tubes are required for the work in order to stand the hammering and vibration to which they are subjected, ordinary tubes being found to crack in all directions. Another common mistake is that these tube wells can be of no use beyond 30 ft. Hundreds have been driven to much greater depths, and in nineteen cases out of twenty the water from the springs when tapped rises to within reach of a suction pump, occasionally flowing over the surface. Where the water does not rise to within reach of suction, special modifications, hereafter described, meet the contingency.

The process of driving tube wells resembles pile driving, but with this distinction, that while piles receive the blows of the monkey on their heads, the tubes are not struck at all, the blow being communicated to the clamp, which receives the blow near the ground. The tube well, as ordinarily used, is not intended for piercing rock or solid stone formations, but it is quite capable of penetrating very hard and compact soils, and can also be successfully driven through chalk, breaking through the flints which may obstruct its passage downwards. When solid masses of rock or stone are reached, special means of drilling have to be provided for it. When coming upon rock or stone the best plan is to pull up the tube and try in another spot. This applies also when deep beds of clay are driven into, for by going a little distance off and testing again in many cases water will be found. The mode of operation is as follows: The first or pioneer tube A —shown in Fig. 1—is furnished with a steel point of bulbous form, and perforated with holes varying from ¼ to ½ in., extending from 15 in. to 3 ft. upwards from the point. The enlargement of the point serves to clear a passage for the sockets by which the tubes are screwed together. On to this tube the clamp B is fastened by two bolts at about 3 ft. from the point; the clamp is of wrought iron, lined with steel, and screwed internally so as to form teeth to grip the tube. Next the cast iron driving weight or monkey, C, is slipped on to the tube above the clamp. The tube thus furnished is stood up perfectly vertical in the center of the tripod or shearlegs, D D D, in which it is retained by the latch E. The feet of the tripod should be looked to in order that they be firmly planted, and do not slip or sink during work. The whole being now arranged in position for work, the ropes, F F, are made fast to the monkey and passed over the pulleys of the tripod, and driving is commenced by two men pulling the ropes and allowing the monkey to fall on the clamp. At this point particular attention must be paid to frequently tighten both the bolts equally as the driving proceeds, for the clamp must not on any account be allowed to slip, otherwise the blow of the monkey is in a great measure lost, the result being no good to either clamp or tubes, besides wasting time. As soon as the clamp reaches the level of the earth by dint of repeated blows, the monkey should be raised, and one man, taking a turn of his rope round one of the legs of the tripod, holds the monkey suspended while the other loosens the bolt of the clamp and raises it about 18 in., and tightens the bolts again as at the commencement. If the ground be very soft the clamp can be raised 2 ft. or more, as it saves the frequent readjustment; if very hard, not more than 1 ft. In this manner driving is continued until the top of the tube comes below the hole in the tripod head, or top plate. Immediately it reaches this point the lengthening bar (Fig. 2) is brought into requisition by dropping its small end into the top of the well tube. The object of this lengthening bar is to keep the tube steady, and to enable the operator to have a temporary guide for the monkey to slide on, until the well tube has been driven into the ground to within a foot of its entire length. This, as will be readily understood, could not be accomplished by screwing on a fresh length of tube, as the socket joint would not allow the monkey or clamp to pass over it. When driving in hard ground the lengthening bar is apt to rebound, and in so doing it would burr the well-tube; but to obviate this a small India rubber ring or washer formed of twisted string is placed at the shoulder. Before the tube has, however, been driven thus far, a hollow iron plumb is lowered into it, so as to ascertain whether water has been reached, or whether earth of any kind has got into the tube. This indicates what depth of earth or water stands in the tube. If neither are present the iron plumb will strike plainly on the bottom of the tube; should earth be present, by allowing the plumb to strike on it once or twice, some will adhere to the bottom, and thus indicate the nature of the soil. It should here be mentioned that, after the first tube has been driven, the well should be plumbed again as soon as the second tube has been driven, say, 3 ft. or 4 ft. into the ground, and every 2 ft. or 3 ft. afterwards; otherwise, by neglecting this, a seam of water may be passed without knowing it. If, after more or less driving not more than a few inches of earth, and that of comparatively dry nature, be found in the tube, no notice need be taken of it; but should it increase to a foot or more, it should at once be removed by the aid of the cleaning-cut tubes. To connect the fresh tube, the monkey is first suspended in the manner previously explained, and the clamp removed from the tube that has been driven and fastened on to the length of tube about to be added to the well, at about 6 in. from the end of the tube which has the socket, the small end of the clamp being towards the end of the socket. The tube with the clamp on it is then passed through the suspended monkey and secured in its place in the tripod head, and then screwed as tightly as possible on to the tube that has been driven. In fact, the tubes must meet or butt against each other, and the joint altogether must be made so tight that it cannot unscrew in the course of driving. Length after length in this manner added until the desired depth is reached.

When earth or clay finds its way into the tube while driving, it is removed by means of small cleaning-cut tubes, usually ¼ in. internal diameter, which are provided in lengths to suit any depth. A sufficient number of these to reach to the earth in the well tube must be screwed together, and each should be carefully lowered into the well tube, all but about 6 in., and sustained in this position by tongs, while another length is screwed on to it. Care must be taken in lowering these tubes not to let them slip down, otherwise considerable trouble will be caused in recovering them. When the accumulation in the well tube is of a loose sandy nature, if wet it can best be withdrawn by means of the pump, which, with the reducing socket, can be coupled on to the top of the cleaning-out tubes. When this is the case, before screwing on the pump, the funnel (Fig. 3) should be screwed on the top of the well tube, so that, if necessary, water can be poured down the well tube, when, by pumping, sand and mud will be pumped up, and by continuing to pour fresh water down the tube, and pumping up through the small tubes, all the earth can be removed.

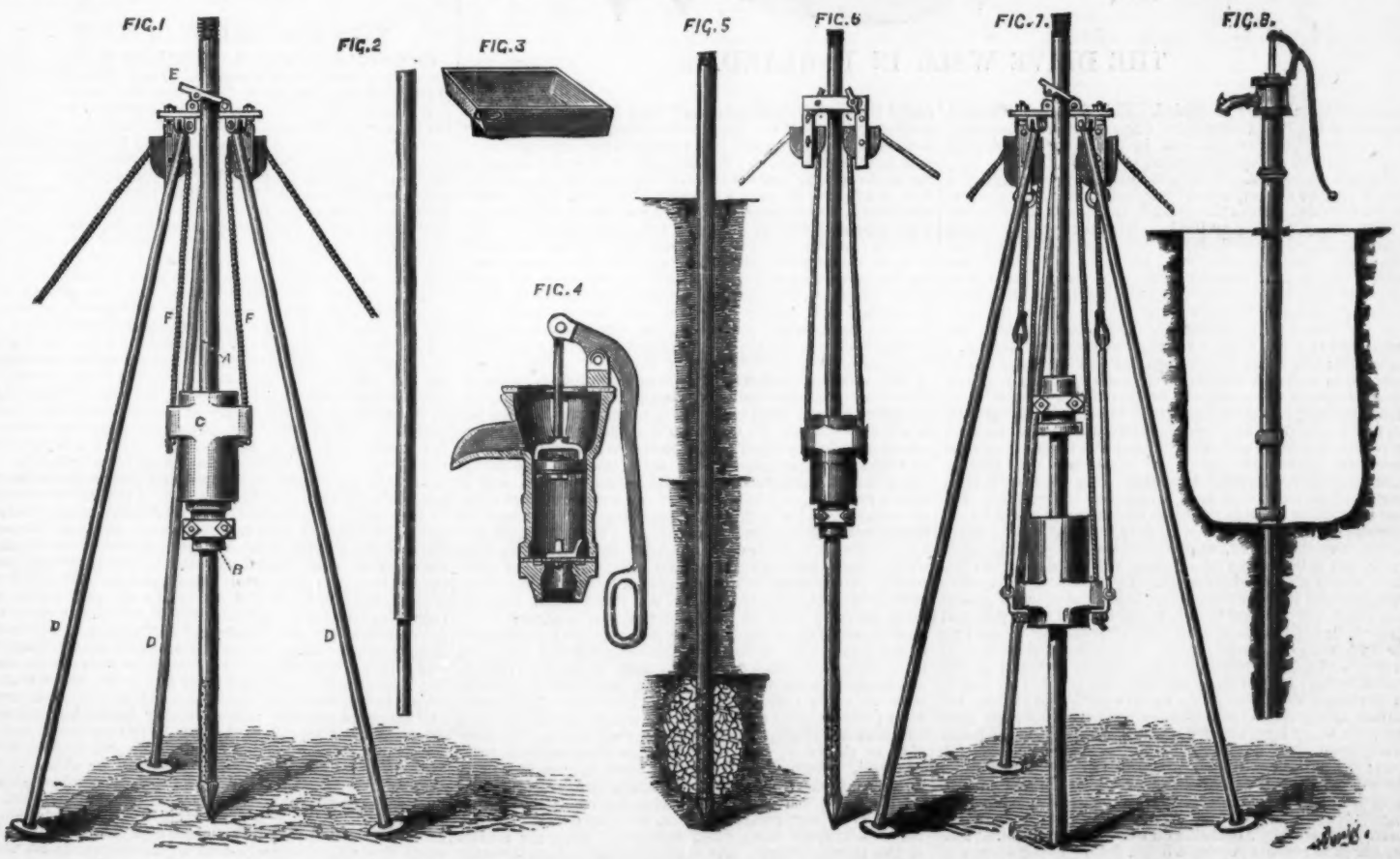
When water is struck, and stands several feet in the tube, the pump (Fig. 4) can be applied. This is furnished with a broad, open top, in order to facilitate the removal of sand, etc., which may accumulate. It requires simply to be screwed on to the tube well with white lead. To start the pump, some water is poured to prime it, and when the air has been exhausted, in all ordinary cases the water will follow. At first the water pumped will be muddy and gritty to a greater or less extent, according to the nature of the strata. After pumping for a short time, and the water shows signs of clearing, the handle of the pump should be raised high for a second or two; by doing this the bucket will press on to the spur on the clack valve, and cause it to open, and simultaneously the tumbler valve in the bucket will be raised, upon which the water will run suddenly down the tube, which a few strokes of the pump will recover; and this should be repeated several times. The result of this sudden letting down the water several times, and stopping it before it has got down to the water level of the well, causes the water to force its way violently in and out of the perforations at the bottom of the tube well, disturbing the mud and fine particles of the stratum around the perforations. If this has been done properly, the water will again become muddy and thick, as at first, and steady pumping will, in a short time, bring up all the mud and fine particles which have thus been disturbed. The object of this stirring up of the mud is to thoroughly disintegrate the soil, and clear away all the finer particles in the immediate vicinity of the perforations, leaving the larger stones and grit to form a natural filter around the tube well. Fig. 5 shows a tube well that

* The origin of the drive well is so well known that it seems like a singular omission, on the part of the writer of this excellent paper, that he should have failed to make explicit mention of the authorship of the invention, and give full credit to whom credit is due. He allows his readers to suppose that the invention was practically unknown and unused until Norton's "indomitable energy" produced the appliances that made it practical, etc. The real truth is that Mr. Norton was simply a copyist, who, several years after the invention and all its appliances had been worked in America, and was in extensive public use, carried it over to England.

The drive well is the invention of Nelson W. Green, of the State of New York, and was first put into practical application by him in 1861-'2, during the late civil war, while he was Colonel of the 78th New York Regiment.

The invention was promptly adopted in the American Army, was used throughout the war everywhere by the Union soldiers, and spread rapidly into general use in all parts of the country. Our great war was brought to a close in 1865, and it was not until nearly three years thereafter, namely 1867-'8, that the British Expedition to Abyssinia made practical use of the invention. Prior to that time, several hundred thousand drive wells were in use in the United States. To-day, in the State of New York alone, it is estimated that a quarter of a million of these wells are worked.

The United States Courts sometimes ago, on the most conclusive proofs, awarded the priority of invention to Col. Green, in whose name the American patent stands.



THE DRIVE WELL AS USED IN ENGLAND.

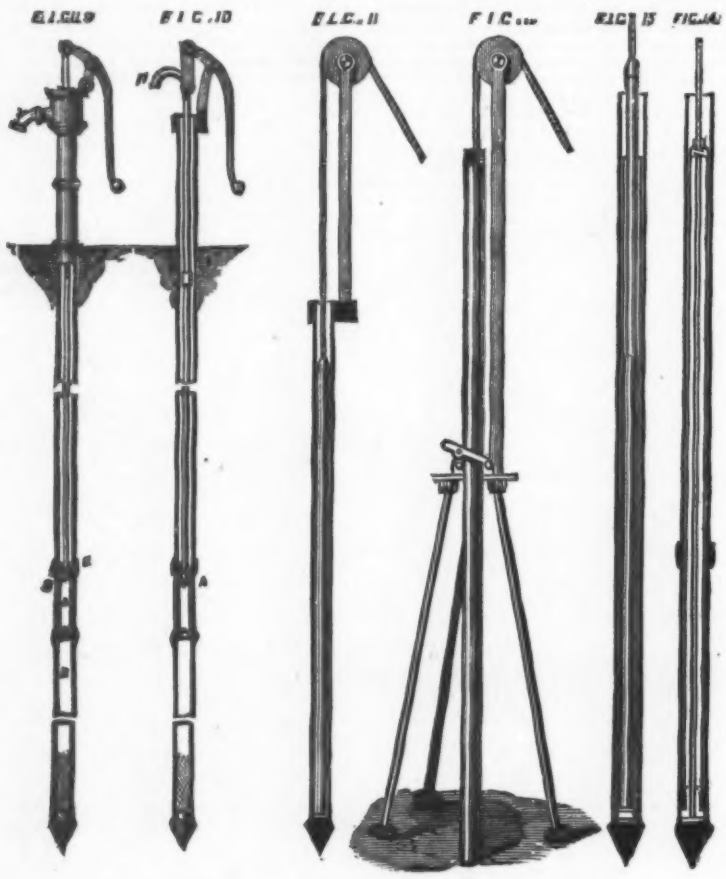
has been driven, and the soil disintegrated around the perforations in the manner described. This process could be repeated several times, until it is found that the mud ceases to come up; for upon the careful carrying out of this greatly depends the quantity of water which the well will yield, and the ease with which it can be pumped. The neglect of this will, in many soils, cause sand to come up some time after the well has been made, and will diminish the yield, and also the ease of pumping. Moreover, in some strata, if this be not properly done when the well is first made, the sand will accumulate in the tube well, and tend to stop the supply altogether.

When first starting to pump a well in the manner just described, should the sand accumulate so fast as to prevent the pump from raising the water, the cleaning-out tubes must be employed, in order to pump up all the sand clean out of the tube; and when this has been done, the pump can again be screwed on to the tube well, when in most cases it will be able to pump up the rest till the well has been cleared. If at first the water only comes with great difficulty, it must not be concluded that no supply can be got; on the contrary, in nine out of ten cases, by a free use of the tilting action of the pump, the compact earth will be broken up and loosened, so that after half an hour, or it may be several hours' pumping, it will produce a perfectly free yield, where at first it was difficult to get half a supply, and a little perseverance will be amply rewarded. Fig. 6 shows the plan adopted by the Royal Engineers, dispensing with shearings on account of their weight, and in their place employing simply a pair of pulleys clipped on to the tube itself.

When from any cause it is found necessary to withdraw a well, it may be accomplished by fastening the clamp to the tube a few inches from the ground, and making a fulcrum of the monkey, prizing up the tube with the lengthening bar or any available lever, lowering the clamp after each successive lift. Another plan, when the tube is very firmly imbedded, is to put the monkey on the pipe the reverse way to what it is when driving the well, and then fasten the clamp on the tube also the reverse way, about 2 ft. above the monkey. A man on each side pulls up the monkey against the clamp, and this drives it upward out of the ground. Fig. 7 shows this: the work, which would otherwise be very laborious, is, by a simple contrivance, made quite easy. The whole weight of the monkey is supported by two stout India rubber springs, similar to those used to close doors. All the workmen need do is to give the momentum to the monkey by pulling the ropes and cause it to strike upwards against the clamp. When the tubes are withdrawn they may be redriven in another spot. In withdrawing the tubes each joint must be unscrewed as it is raised to the surface. Before attempting to drive the tubes afresh they should be examined to see that they are perfectly straight. Bent tubes should never be driven, as they are not only apt to bend worse, but if they come on anything very hard they are liable to spring and not drive at all. In cases where the water level is found to be but a few feet below the reach of a suction pump, the simplest plan is to dig down 5 ft. or 6 ft. and take off the top length of tube, and, after having cleaned up the well with the usual pump, a long beveled pump—as shown in Fig. 8—reaching to the surface is attached to the well tube, and the hole that has been dug is filled up again, as the lower box of the pump can always be got at from the surface at any time it may require seeing to. Where, however, the water level stands some considerable depth below lifting reach, the plan adopted—shown in Fig. 9—is as follows: When the first tube has been driven into the ground, the working barrel, A, consisting of a short length of tube lined with stout brass, together with the conical brass seating, B, is screwed on to the tube which has been driven; next, the washer, C, is placed on the working barrel. This washer is to prevent the brass lining from jarring up out of its place while being driven. To this working barrel are then added fresh lengths of tube, driven in the usual way, until the barrel reaches just below the water level. The bucket, D, connected with suitable lengths of rods is lowered into the working barrel and attached to the lever in the pump head as shown. In clearing up these deep wells, owing to the comparatively large size of the tubes employed, the up current of the water when pumping is not of sufficient velocity to carry up with it the heavier portions of grit, etc., which, consequently, accumulate in the barrel. To overcome this difficulty a sort of a plunger pump of a novel description has been designed—Fig 10 shows a section. The plunger box, A, is furnished with double cup leathers placed in reversed positions, *i. e.*, one cup downwards and the other upwards; a tumbler valve is fixed at the bottom, the tubular rod which carries the plunger box communicates with it, and when the lever of the pump head is raised, the water, grit, etc., instead of passing slowly up the long well tube is forced rapidly up the small tubular rod, from whence it is expelled at the outlet, B, and by this means all the heavier particles can be effectually cleared out of the tube well.

It may be observed that Mr. Norton's patents passed into the hands of Messrs. LeGrand and Sutcliff, of Magdala Works, Bunhill-row, London, a few years back, and this firm has recently patented an entirely new method of driving tubes applicable for wells, and for other purposes, which the author will now briefly describe. In practice it has been found that, when driving in very hard bands of strata, immediately the point has penetrated through them the driving becomes quite easy again, irrespective of the depth that may may have been reached. For instance, it is quite common for a tube to take many hours driving through an obstruction of 3 ft. or 4 ft., met with say at 20 ft. or 30 ft. below the surface, and subsequently driving at four times the pace when reaching possibly double or treble the depth.

From this fact, it is quite evident that the first tube with its point accomplishes the whole work of penetration, leaving the tubes that follow practically no resistance to overcome. Instead, therefore, of striking the tube at or about the surface as in Norton's method, and having to transmit the blow through any length of pipe, varying according to the depth driven, Le Grand and Sutcliff's arrangement delivers the blow immediately above the point at the bottom of the tube—in fact, exactly where the blow is wanted. This is accomplished in a very simple manner by using an elongated weight, shod with steel, which passes down the inside of the tube. To this weight is attached a long rope, which is pulled by hand and allowed to fall, striking upon an even surface provided at the top of the bulbous point; this is the most simple form of working on this plan, and is shown in Fig. 11. Fig. 12 shows a more convenient form of working, which consists of a short shearlegs, the head of which serves as a guide for the tube, and from this head rise two tubular uprights, to carry a pulley over which the rope travels, and which can be worked either by hand, or other power. One feature of the new system is, that it does away entirely with the risk of bending the tubes when they get on to anything hard; on the contrary, the tendency is to keep them perfectly straight, and the tubes are not damaged in any way. Fig. 13 shows a plan—suitable for tubes of large calibre—for shutting out any sand, which might get in and impede the blow. It consists in providing the weight with an outer casing, in which it can freely slide up and down; the shoulder provided on the weight enables it, when withdrawn entirely, to bring the casing up with it. Another plan is shown at Fig. 14. This acts upon the pneumatic principle. The bottom pipe, about 4 feet long, without perforations, is smooth drawn and slightly smaller in its internal diameter than the tubes which follow it; the driving weight is hollow, consisting of an outer and an inner tube, the annular space being filled with lead. Near the bottom of this driving weight, which is steel shod, a rope or other suitable packing is fixed, so that it acts as a plunger. At the top of the inner tube of the driving weight is fixed a valve, which allows any air to escape as the weight drops. When the weight is lifted, a partial vacuum is created beneath it. This increases the labor of raising the weight, but the additional labor thus expended is nearly all returned in the augmented rapidity with which the partial vacuum causes the weight to fall. This plan of internal driving is found to be very applicable for driving tubes of large diameter, as the tackle required is so simple and inexpensive; it also commends itself most favorably for driving under water, as by its means a tube can be driven at the bottom of a well which is, more or less, full of water. The process is not by any means confined to well-sinking purposes. Iron piles can be driven most effectually, particularly where there is a great depth of water, it being quite practicable thus to drive piles 50 feet or 100 feet below the surface of the water. On a smaller scale the plan is also well adapted for driving telegraph posts with rapidity for military or permanent purposes, as well as for tubular posts for wire or other fencing. The uses to which the smaller sizes of tube wells are adapted are very various; to a great extent they supply an important want of the present day in furnishing pure water for domestic use, and thus replace the old dug wells which in most rural districts are found contiguous to cesspools, and with few exceptions are more or less contaminated by sewage. In numerous instances, by driving one of these tube wells some 16 feet or 20 feet below surface springs, a pure supply can be obtained, for these tubes are found to perfectly shut off all communication from the impure water in the upper seam. To give an instance, out of many hundreds, at Brandeston Hall in Suffolk, the dug well which supplied the household being found to be impure, thereupon a tube was driven; and after passing a very compact bed of clay some 20 feet thick, chalk was met with at 36 feet, and an abundant supply of perfectly pure water obtained. The smallest sized wells are advantageous for manufacturing purposes, for supplying moderate sized boilers with feed-water, not only in rural districts, but in towns supplied by water works, thus saving heavy water rates. Many are thus in use for similar purposes, even in the very heart of London, springs being found to exist in many spots when it might have been expected that deep sewers had drained away all the land springs overlying the London clay. As it is not uncommon for a 1¼in. tube to yield from 500 to 600 gallons per hour, constant pumping, contractors in erecting large buildings find them very useful both for supplying their engines and for mixing mortar, and on the completion of the contract they are taken up ready for use elsewhere. This feature of being readily transportable from place to place renders them invaluable for railway contracts, and especially so for exploring expeditions, Sir Samuel Baker and others having employed them in Africa and elsewhere for that purpose. Another use to which they are daily put is for testing ground to ascertain how deep water lies below the surface, to test the quality and quantity obtainable before sinking larger permanent tube wells. It will readily be seen how valuable such a rapid means of obtaining such data becomes, as before purchasing land for any purpose, the primary question of water supply can thus be settled. The firms of Messrs. Mann & Crossman & Messrs. Truman, Hanbury & Buxton, among many others, availed themselves of this medium to test sites of land before purchasing them for building their branch breweries at Burton-on-Trent. It will also be seen that this principle of testing land is not confined to water purposes, for it is equally adapted for testing for foundations more expeditiously than any other known plan. In fact, tube wells must daily become more and more an indispensable adjunct to the plant of engineers and others dealing with land projects generally, and the only wonder is that such a very simple invention should not have seen light many years sooner than it did. Within the limits of a short paper like the present it is not possible to do more than very briefly describe the smaller sized tube wells and appliances, those of larger diameter requiring more complicated apparatus.—*The Engineer.*



THE DRIVE WELL IN ENGLAND.

YORKSHIRE COLLEGE OF SCIENCE.

ON the 23d of October, the Archbishop of York laid the foundation stone of this college. There were present the Mayor and Corporation of Leeds, the Mayors of Huddersfield, Wakefield, Richmond, Hall, Dewsbury, and Batley; the Master and Wardens of the Clothworkers' Company, and other invited guests. After the stone had been laid, the company adjourned to the Great Northern Hotel for luncheon, the chair being taken by Lord E. Cavendish, M.P. The governors have purchased the Beech-grove estate, extending over more than three acres, for £13,000. Only buildings for the accommodation of the Textile Industries Department will be proceeded with at present, for the erection of which the Clothworkers' Company have made a grant of £10,000. This department continues to be the most flourishing portion of the college. Its winter session was commenced with an address from Mr. Beaumont on "Feather trimming." Mr. O. Nussey, J.P., presided. The lecturer illustrated the several processes by examples manipulated at the college from but rude appliances, and also placed on the blackboard the plan and draft for its operation in the loom, as well as gave the particulars needed in its composition. The texture, as woven on one of the looms in the college, was handed round for inspection. Mr. Beaumont afterwards made a few general remarks on the necessity for such a department, considering the advanced strides which other countries are making in this respect by multiplying their schools for the cultivation of taste and design, and said that if we intended to maintain our position in clothing productions, or keep pace with them in elaboration, it must be by a thorough study of those principles which govern them, and a greater diffusion of such knowledge among the handicraftsmen, upon whom depended the practical operations by which the result is attained. He was pleased to say that a very encouraging success had attended the efforts in connection with the college so far, and he augured still greater in the future if he were only supported by the assiduity of the students, and supplied with the means sufficient to the end in view. Mr. Nussey said that he had been highly gratified while listening to Mr. Beaumont's address, and that the more he heard and thought about our manufacturing industries and what other countries are doing, the more he felt convinced that we must make an effort to keep our position and to keep ahead of them as much as possible. That was the object of the Textile Industries Class, and he hoped it would be well supported by students anxious to learn, and by those who had the power to materially help the institution in its undertaking. In Mr. Beaumont they had a gentleman in whom they had every confidence, and who took a deep interest in his work, and was well qualified to impart that instruction to those who come to him, which would be a lasting good to all concerned.

LESSONS IN MECHANICAL DRAWING.

By PROF. C. W. MACCORD.

Second Series, No. XX.

The Screw Propeller.

THE study of the screw propeller, as our readers have no doubt observed, is admirably calculated to give clear ideas of the mode in which surfaces are generated by the motion of lines. Those who had given no previous consideration to this or similar matters, would at first be better able to form accurate conceptions of this particular surface, by regarding it in the concrete, as bounding a solid, to which the shape was given by coiling a flexible bar, or in some analagous manner, as in the illustrations introduced at the beginning; but such physical conceptions once formed, it at once becomes necessary, in order to represent it, that it should be regarded in an abstract manner as defined by certain lines which may be imagined to be drawn upon it: and by thus regarding it we are enabled to deduce processes not only of representing it upon paper, but of moulding it for actual

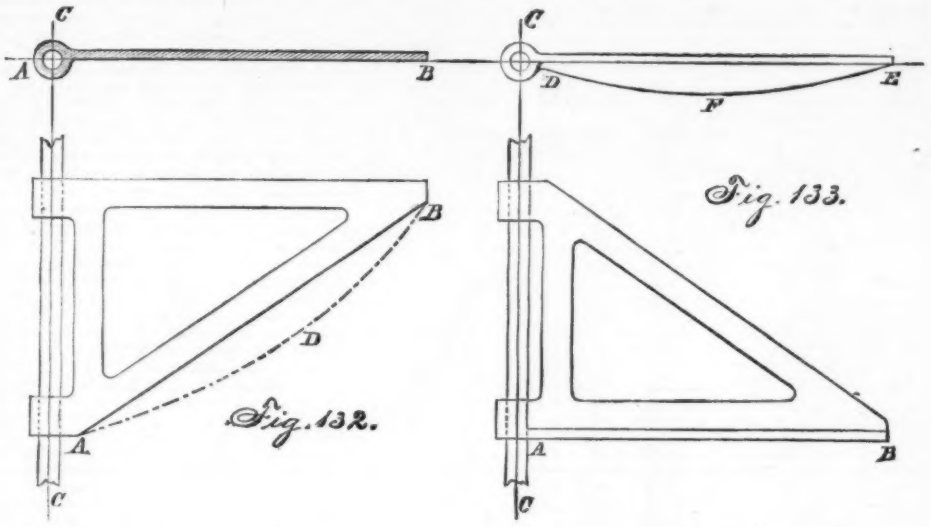


Fig. 132. Fig. 133.

LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 20.

construction, with a degree of accuracy and facility which could hardly be otherwise attained.

Now, when a surface is defined as being generated by the continuous motion of a line, it is usual to give the simplest mode, which ordinarily is all that is needed. When, however, the student confines his attention to a single method, he not only fails to gain a perfect and complete acquaintance with the abstract properties of the particular subject under consideration, but may fail to perceive things which will at some time be of practical value. For example, let us take a simple cylinder; this is generated by the revolution of a right line around an axis parallel to it, or, what comes to the same thing, by moving a right line in such a way as to be always parallel to itself and in contact with a circle to whose plane it is perpendicular.

This definition is in itself clear and simple, and has the advantage of relating to the right line, which is the simplest element of the surface. But he who can define the cylinder in no other way, evidently cannot have as comprehensive an understanding of its properties, as he who sees that a helix, or indeed any line whatever which can be drawn upon the surface after it is generated, will by revolving about the axis reproduce the same cylinder as well as one of the rectilinear elements; that the circular base will generate it by sliding along the axis or an element, keeping always parallel to itself, like the piston of a steam engine; and that the ellipse formed by an oblique plane section will generate the same cylinder in either manner.

It may be that these considerations in themselves are not of great practical importance in this particular case; but we are aiming to impress upon the reader the fact that a thorough mastery of any subject can be obtained only by regarding it from different points of view. And this is most emphatically the case in the study of the screw propeller; a subject whose importance we think fully warrants the introduction of the various modes of illustration to which we had recourse. We hope, therefore, that it will not have escaped the notice of the student of the preceding articles, that the surfaces discussed may be generated in modes different from those explained. For instance, in the first and simplest, the right helicoid, we are not absolutely confined to the use of the rectilinear generatrix. To be sure, that is the simplest and practically the best; but, nevertheless, it is clear that if we regard merely the circumstance that the surface is made up of helices all having the same uniform pitch, we may draw any line whatever upon it, and, by moving this line so that each point shall describe such a helix, generate the same surface. And this motion may be given to the line, by the same device which we described as actually used in striking up the blade with a straight-edge, that is, by allowing it to revolve while traveling endlong upon a central shaft, regulating the ratio of the longitudinal to the rotatory motion by means of a guiding curve, which in this instance is merely a true helix.

So too, in regard to the oblique helicoid; the blade of the propeller shown in Fig. 103 may be struck up by an inclined straight-edge, the axis being vertical, which is the method spoken of in connection with that figure, and practically the best and simplest. But it may also be moulded by the use of a horizontal "striking-board," if the latter be properly curved. Thus in Fig. 132, *A B* in both the side and the top views represents the inclined rectilinear element; this being arranged to slide and turn upon the vertical shaft *C C*, will, if a true helical guide curve be used, generate the oblique helicoid, and the pitch being given, we can readily find as explained in Lesson XV the transverse section, which was then shown to be an Archimedean spiral. Now let us substitute for this striking-board the one shown in Fig. 133, when *A B* is horizontal, and *D F E*, the top view, is accurately cut to the form of this spiral. It will then be clear that if the same guiding curve be used, the surface struck up will be the same as before. In both the right and the oblique helicoids, it is obvious that all this depends upon the fact that the curvature of the surface in each case is the same throughout its length, so that if a piece of it be supposed to be detached, it will, if kept at the same distance from the axis while revolving about it, fit the helicoid anywhere. From which it follows that we are not confined to the use of a plane section as a generatrix, but any line drawn at pleasure upon the surface from axis to circumference will generate the helicoid, any one of the helices being used as the guiding curve.

Of course, no possible advantage could be gained in the cases mentioned, by selecting a crooked generatrix when a straight one is able and willing to do the same work; but we shall see presently that the general principle will enable us to simplify matters when we must or may choose between lines of different kinds and degrees of crookedness.

It might at first thought appear that the same would hold true in the case of the screw with axially expanding pitch, Fig. 127, since the pitch though not uniform is the same for every helix of which the surface is composed. But a little closer study will show that this is not so; for the reason that the curvature of each helix is continually changing. If then we draw any line upon this surface, the curvature of the path of every point in this line must be determined by that of the helix which is used as a guide curve. From this it follows that if we draw two lines on the surface to the axis, from the same point on the guiding helix, the path of every point in both lines will be a helix having a rate of increase in pitch corresponding to that of the guide curve at the point of contact; if at a given distance from the axis, then, we take a point in each line, these two points will describe similar helices, but they will not coincide, nor will either of them lie in the surface, unless one of the points lies on the original generatrix.

Now it will readily be seen that the device illustrated in Fig. 133 is capable of indefinite extension; that is, we may make the "striking-board," whose edge is the generatrix of the proposed surface, of any form we please, of single or of double curvature.

We may also use as a guide curve a true helix, or one of increasing pitch in any case, and thus strike up an infinite variety of surfaces, all of which are helicoidal in the sense that they are made up of helices, true or otherwise, but none of them *warped* surfaces, or containing right lines. And in fact this has been done—and by selecting different portions of these surfaces, limited in various ways, there have been made an endless list of propeller blades, bearing more or less resemblance (generally less) to a sickle or a sabre, an eagle-wing or a scoop-shovel, according to the fancy of the designer; each one being, of course, better than any other. By all of which we do not mean to cast any slur upon the judgment of the designers; there are, unquestionably, good reasons why one propeller gives better results than another under certain conditions, and worse under others, for otherwise it would not be so. But with those reasons we have nothing to do; we are addressing the reader, not as an engineer, but as a draughtsman: the modifications to be met with are innumerable, and each has its own zealous advocates; without giving preference to any, we wish to enable the student to represent all.

In making a propeller with a curved generatrix, it is clearly most convenient to use a curve of single curvature; and it is equally clear that one would naturally choose either a radial or a transverse plane as the plane of curvature. The latter is done in Fig. 133; and in Fig. 134 we illustrate the mode of procedure in making a drawing of a blade in this case. It is quite unnecessary to give a complete drawing of the blade, as it involves merely a repetition of the process shown in the diagram. The curves 1, 2, 3, 4, in the end view, are different positions of the generatrix, corresponding to the right lines 1, 2, 3, 4, which represent in the side view the transverse planes in which these generatrices lie; the spacing in both views is uniform, because the guide curve is supposed to be a true helix—it need hardly be said that if the pitch increase axially, the only modification will, as shown in the preceding lesson, be in this spacing, which has nothing to do with the form of the generatrix. Nor does the curvature of the generatrix materially affect the detail of the construction, while the principle of the method is entirely unchanged. For the purpose of illustration, we have as in most previous cases assumed a space bounded by the dotted line in the side view, within which the screw is to revolve. From this we are to determine the appearance of the blade in both views. We observe that in the side view the plane 4 cuts the assumed outline in two points, *m* and *n*, which are the highest revolved positions of points actually lying on the curved element 4 in the end view.

As heretofore, then, we project *m* and *n* to *m'*, *n'*, revolve them to *o'*, *p'*, and counter-project these points to *o*, *p*. In precisely the same way we may ascertain as many points as we please, not only in the outline of the blade, but in its intersection with the hub, and having these two views we can construct the third, by the usual methods. Of course, in this case, as in all others, the blade may be otherwise limited; we may assume the end or side view of the blade, and from that determine the other view and the space swept out in revolving, but the construction is, or ought to be, by this time too obvious to require explanation.

In Fig. 135, the generatrix is also curved, but lies in a radial plane, as though the striking-board in Fig. 132 had been the dotted curve *A D B* in the side view. The conditions here are the same as in Fig. 134, that is to say, the outline of the space is assumed, and the form of the blade found from it. The generatices here appear as radii in the end view; and the construction is the same as before, the only difference in detail being this, that since each point describes a circle in a transverse plane, the points *o* and *p* are vertically under *m* and *n*, and not on the side view of the generatrix; which, indeed, is not strictly a difference either, because it happens that in Fig. 134 the side view of the generatrix is a vertical line.

In this case also, we may use either a true helix, or one of expanding pitch, as the guide curve, the spacing of the elements in the latter case being determined as explained in the preceding lesson.

We might in the last two figures have curved the generatrices in the opposite direction, thus again varying the form of the acting surface. These variations, however, we do not introduce, in the form of special or isolated cases; for the reason (aside from the fact that the student may readily construct them for himself if he is anxious to see how they look) that a more broad and comprehensive knowledge of the subject may be gained by generalizing to a certain extent.

In Fig. 136, *a b d* is the longitudinal section of a V-threaded screw. We have already seen that if we make a transverse section of the part generated by *a b*, as at *v v*, its form will be that of an Archimedean spiral, which, when viewed from the direction shown by the arrow, the screw, being a right-handed one, will appear as *z w z* in the end view; while a similar section of the part generated by *a d*, as at *x x*, will be the similar but opposite spiral *u u*. And we have found that the smaller the angles *b a c*, *d a c*, the less will be the curvature of these spirals, until, when *a b* and *a d* coincide with *a c* perpendicular to the axis, this curvature vanishes, the spirals become radii, and the V-threaded changes to a square-threaded one. Now, it is perfectly easy to make a right-handed screw whose meridian section shall be bounded by curves, convex as in Fig. 137, or concave, as in Fig. 138. For the sake of comparison, the elementary triangle *a b d*, whose sides are replaced by these curves, is made the same in all the figures. Confining our attention to the surface generated by *a b*, we find that *z o z*, a transverse section at *v v* in Fig. 137, has a greater curvature than the original Archimedean spiral, while that in Fig. 138 has a less curvature *z-o z*, but the direction of the curve is the same in all cases.

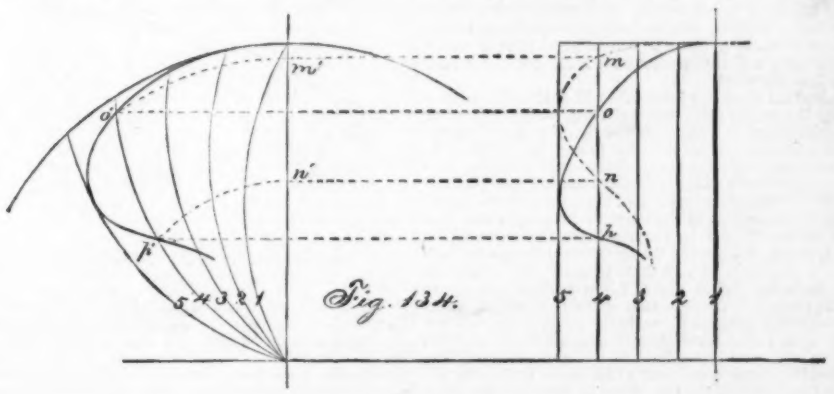


Fig. 134.

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We see, then, that just as the surface of the square-threaded screw is the boundary between the two sides of the V-threaded one, so the V-threaded screw is the boundary between two other screw-surfaces, whose generatrices are respectively convex and concave toward the axis. If the pitch be uniform, all the transverse sections of any one of these surfaces will be alike, and so will all the radial sections; so that, as we have already seen, either of them may be struck up by means of a "striking-board," curved in either a horizontal or a vertical plane. This cannot be done, for reasons above pointed out, if a helix of varying pitch be used as the guiding curve; but from these figures it is easy to see that the general nature of the surface will not be changed by that modification.

It was remarked that the general principles involved in the preceding, might sometimes enable us to simplify the construction of a propeller which is to made according to given conditions. To be sure, this rarely happens, but we have an instance in point, which is illustrated in Fig. 139.

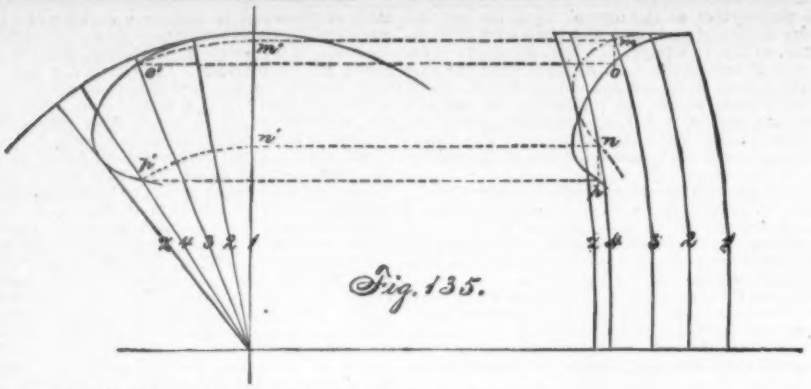

Fig. 135.

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This looks innocent enough—but in this case appearances are deceitful. *C B* is the radius of this screw, whose pitch is given: now, supposing it to be an ordinary true screw, or right helicoid, the surface is readily defined. But this is only the basis, upon which for some inscrutable reason the designer chose to erect the following superstructure: the curve *A D*, instead of being a generatrix laying in transverse plane, is intangent; but now the generatrix being curved, we must construct the tangent to it. This done, the tangent plane is determined, and the process of drawing the normal will then be substantially the same as in Fig. 104.

Now the generatrix may be a definite mathematical curve, whose properties we know, or it may not—as in the case just mentioned in connection with Fig. 139.

the circle *s v* in the point *p'* and *P p'* will be tangent to the curve as required. For by the construction of the auxiliary curve *a d*, the distance to be set off from *p'* will be zero.

It may, however, happen that this auxiliary curve will cut the circle *s v* at a very acute angle, so that the exact point of intersection *p'* is not easily determined. In that case, upon the principle that "twice nought is nought," we may set off from the circumference distances found by *doubling* secants *P, A, B*, thus changing the direction of the auxiliary curve without vitiating the property upon which its utility depends.

This construction applies to plane curves only; but that is sufficient, for even if we have to deal with a surface which can be generated or struck up only by a line of double curvature, we can always make a section of it by a plane through the point at which the normal is drawn, and the tangent to this section will answer our purpose as well as that to the generatrix. The same method of course may also be used if it should be required to make a propeller of a pitch increasing by a different law from that discussed in Lesson XVIII, so that the development of one of the helices should be a curve to which a tangent could not be otherwise drawn.

In all these cases in which a curved generatrix is employed, it is of course to be understood that its position relatively to the axis never changes; for it will readily be seen that if, for example, we use a striking-board curved in a radial plane, with a true helical guide-curve, the regularity of the surface would be destroyed were the generatrix at any time to turn about a horizontal or inclined axis so that its plane should become otherwise than radial. When a rectilinear generatrix is used, its motion, as we have already pointed out, is fully controlled by the condition that it shall always touch three given lines, and the resulting surface is then absolutely determined: but this is not the case if the moving

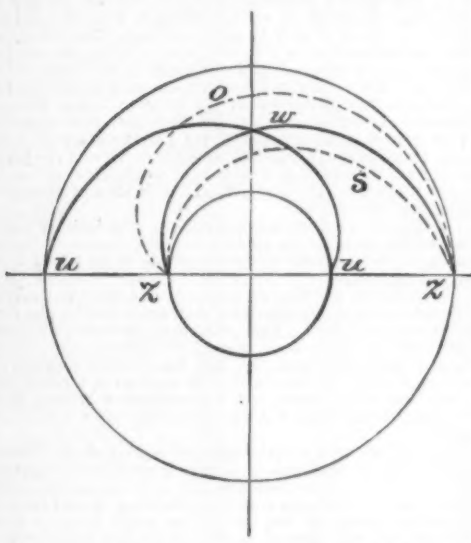

Fig. 136.

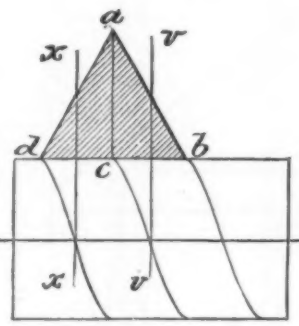

Fig. 137.

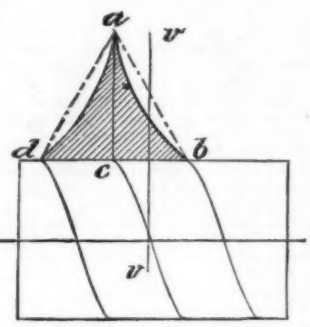

Fig. 138.

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tended merely as a guide to the construction of a double curved line, thus: The ordinates, 1-1, 2-2, 3-3, *B D*, are, we are informed, the actual lengths of *normals* to the original helicoid; and the screw is to be struck up by a generatrix normal.

formed by drawing a line through the extremities of these Fortunately, the pitch is uniform; and though there is still some work for the draughtsman, it is not necessary for the pattern maker to work out this formidable double-curved striking-board. First, then, we construct this line, an operation illustrated in Figs. 80 and 85. This done, it is easy to draw the helices described by various points of it, fully defining the surface, of which we may then make either a transverse or a radial section, thus reducing the problem to the simpler form of making a screw whose generatrix is one of single curvature: which operations we leave for the reader to execute if so disposed.

We believe that what has been said will enable the student to construct the acting surfaces of the screw-blades thus far discussed; the complete representation therefore involves further only the drawing of the normals to any one of them, in order to locate correctly the points determined from the conventional section from which the thickness of the blade is determined. It may bear repetition, that the normal is perpendicular to the tangent at the point of tangency, and that this plane is determined by the rectilinear tangents at the same point, to any two lines of the surface which pass through it. We have shown in Fig. 79 how to draw the normal to the right helicoid, and in Fig. 104 how to draw one at any point of the oblique helicoid. One of the lines employed in each case was the tangent to the helix passing through the given point, and of course this will answer equally well in any other case, such as we have now under consideration. In the helicoids or screw-surfaces which have rectilinear elements, we use, in addition, the element through the point at which we wish to draw the normal, since that is its own

The whole matter therefore hinges upon the construction of a tangent to any given curve—which is illustrated in Fig. 140. Let *M N* be the curve, and *P* the point at which a tangent is to be drawn. Through *P* draw any number of lines at pleasure, cutting the curve at *A, B, C*, etc. About *P* as center, with any radius, describe a circle *Z U*, cutting the random lines at *a'*, *b'*, etc. Then set off *a' a*=*P A*, *b' b*=

line be curved. To illustrate, if we select any three helices of a given oblique helicoid, a right line cannot move in contact with them without generating that identical surface; we have just seen that the same surface can be generated by the spiral forming the transverse section, if while revolving about the axis it be kept in contact with one of the helices; in which case it will always touch the other two, and remain in a plane

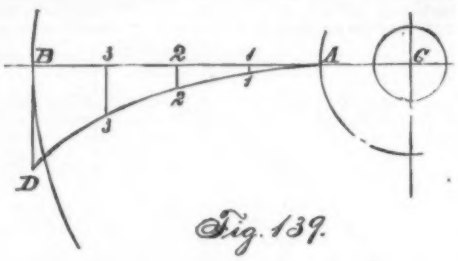


Fig. 139.

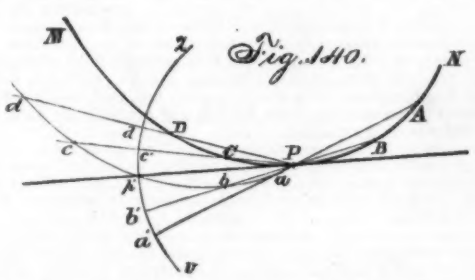


Fig. 140.

LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 20.

P B; it will be observed that *A* and *B* lie to the right of *P*, and that the distances are measured from the circumference of the circle toward the right: *C* and *D* in our figure lie to the left of *P*, and we set off on *P C* and *P D* produced, the distances *c' c*= *P C*, *d d*=*P D*, measuring from circumference toward the left. A curve is now drawn through the points *a, b, c, d*, thus located; this curve cuts

perpendicular to the axis. But if we merely say that this spiral shall move in contact with the three helices, it will be possible for it to do that without remaining in a transverse plane, and thus to generate an entirely different surface, all of whose sections by concentric cylinders will not be true helices. Practically it is obviously much easier to keep it in a transverse plane than not to; but it is well to consider all the possibilities of the case, though it is not worth while to go off upon this side track to investigate the surfaces which might be thus formed, it being evident that they are not suitable for our purposes.

But there is supposed to be a combination which we have not yet mentioned, that is, of a curved generatrix with an axially expanding pitch. We say supposed to be; for though it is true that by substituting a curved striking edge for the rectilinear one in Fig. 115, and using the two true helices of different pitches as guide-curves, a *surface* may be struck up, and we believe it has been used, yet abstractly, as we shall soon see, that surface will not be composed of true helical elements. What occurs will be most readily seen by comparing the surface thus aimed at with the one generated by a right line.

In Fig. 141, the element *a d* in a half revolution rises to *i m*; the curves *d m*, *c l*, *b k*, being true helics; *a p* is *a d* revolved through 180°, and, bisecting *a i* and *p m* at *e* and *h*, we have *i m*, *e h*, *a p*, as three positions of the generatrix revolved into the plane of the paper, as in the previous discussion of this surface. In that discussion it will be recollected that we found the striking peculiarity, that any section of it by a cylinder concentric with it is a true helix, but yet no part of the generatrix describes such a path, the element sliding upon

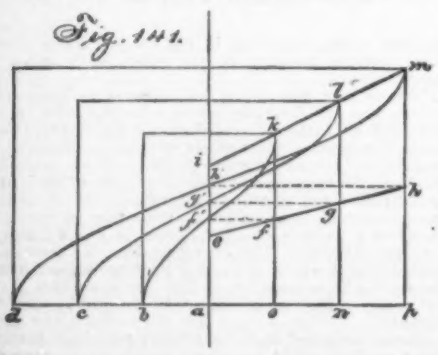


Fig. 141.

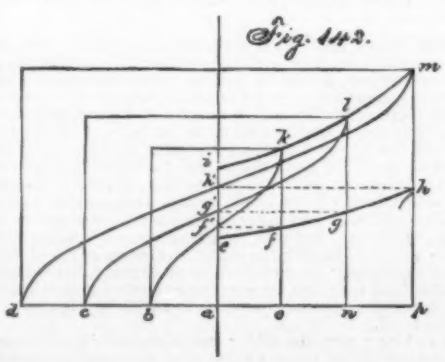


Fig. 142.

LESSONS IN MECHANICAL DRAWING.—SECOND SERIES.—No. 20.

the directrices as it advances, which is evident from this figure when we note that $i m$ is longer than $e h$, and $e h$ than $a p$.

Now in Fig. 142, we have three concentric cylinders, $d m$, $e l$, $b k$, whose diameters are the same as in Fig. 141. We have also, for the sake of comparison, made $a i$, $p m$, of the same altitudes as before; but $o k$, $n l$, are of different altitudes, so that $i k l m$ is now a curve in the plane of the paper, instead of a right line. On these cylinders are traced the true helices, $d h' m$, $c q' l$, $b f' k$; and the reader will readily see that any number of intermediate concentric cylinders may be introduced, cutting $a d$ and $i m$ at points which may also be joined by true helices.

In this way we shall construct a surface, composed, like the preceding, of true helical elements, and with axially expanding pitch. But its sections by radial planes are not, as in the previous case, right lines. Nor are they similar to each other; it is clear that if we suppose the surface to be generated by the revolution of the line $i m$ about the axis, that line in order to remain in contact with the three helices and also in a radial plane must change its curvature as it descends, until when it reaches the position $a d$ it becomes a right line.

By bisecting $p m$, $n l$, $o k$, and $a i$, or what is the same thing, revolving h', q', f', as in the previous instance, we obtain the curve $e f g h$, the revolved position of the section by a plane through the axis perpendicular to the paper, thus giving $a p$, $e h$, $i m$, the three positions of the varying generatrix, corresponding to those similarly lettered in Fig. 141. It will be seen that if we extend this surface below the plane $d p$, it will be divided by that plane into two portions, which will closely resemble the opposite sides of the thread of the screw whose meridian section is given in Fig. 137: a division analogous to that of the surface Fig. 108 by the central plane L M, the generatrix, after passing the position $a d$, becoming curved in the opposite direction.

We see then that the surface discussed in Lessons XVI and XVII is but a special case of a general class: the expression "axially expanding pitch" may evidently be properly applied to any surface composed of concentric helical elements, of which the pitch increases as we recede from the axis. We may also regard any such surface as generated by the revolution about the axis of a line lying in a radial plane, combined with such axial advance as may be determined by the pitches of the helical elements; and in that special case we found that the generatrix would remain straight, though its inclination to the axis was continually varying. The surface shown in Fig. 142 is the one most nearly resembling that of Fig. 141. But there may be a great variety of surfaces which answer to the definition just given, since the rate of increase in the pitch, for the same distances from the axis, may vary in numberless ways. Nothing can give a clearer idea of the nature of such a surface, and of the changes of form in the generatrix, than to revolve equidistant positions of the latter, that is, positions corresponding to equal angular movements, into one plane, as in the case of the three elements shown on the right side of the axis in each of the last two diagrams; and the succeeding ones illustrate in this manner some others of this class, which are given more for the sake of a comprehensive view of the subject than for their practical utility in themselves; though we may, by studying them, find some points of at least a negative practical bearing.

In Fig. 142, the generatrix in ascending assumed a curvature in one direction. It might just as well have assumed one in the opposite; and in Fig. 143 the rectilinear generatrix $a b c$, in rising to the position $d e f$, becomes a curve having a point of contrary flexure at e. The angle through which it turns in rising so far is quite immaterial—it may be more or less than one revolution; but we would point out that, $g h i$ being its position after turning through another equal angle, and $b e h$, $c f i$, being right lines parallel to the axis, h will also be a point of contrary flexure. For $b h$ and $c i$ may be considered as the outlines of cylinders, and on the inner one lies a true helix joining the points b, e, and h. Let $n s$ be the outline of another concentric cylinder, cutting $d e$ in o, and $g h$ in p. Then had the generatrix of the surface within the cylinder whose radius is $a b$ remained straight, the intersection of it by the cylinder whose radius is $a n$ would have been a true helix passing through n, o, and p in space. But this least cylinder cuts the curve $d e$ in r; and making $r s = n r$, the curve $q h s$ must pass through s; which, whatever the diameter of the cylinder on which it lies, will always be above the right line $q h$, because r is above $d e$, and we have by hypothesis $s p = 2 r o$. This part of the generatrix will therefore always be concave toward $a c$; and by reasoning precisely similar we may prove that the part beyond $b h$ will be convex toward $a c$.

It will be observed that here, too, the transverse plane in which $a c$ lies corresponds to L M of Fig. 107, and divides the whole surface into two parts, the generatrices on opposite sides of this plane and equally distant from it being symmetrical curves.

HEATED AIR FOR COMBUSTION.

NEARLY all the processes in actual use for economizing fuel have for their leading principle that of pre-heating the air for combustion. This is a pregnant fact, of which many instances can be found. When Neilson made his invention, or rather discovery, in 1829, he began with a temperature in the blast furnace of 50° Fah., and gradually, in succeeding years, raised it to 600° Fah. By 1850 this was further increased to 750° and 800°, and from 1854 to the present time it has progressed up to 1,100°, 1,400°, and more. To heat the great volume of air for a large blast furnace some 20,000 square feet of fire-brick have to be actively employed. A gas furnace is simply a physical impossibility without using air raised very considerably in temperature above that of the atmosphere; and this was very soon found out by the first experimenters. The Hoffman kiln, which has revolutionized the brick trade, is highly economical in fuel mainly because the air for combustion is intensely heated by first passing through the already burnt, incandescent bricks. In Siemens' regenerative furnaces, and in the furnaces with direct-acting regenerators of the French engineer Ponsard, the air and gases for combustion are brought to high temperatures by being conveyed past considerable surfaces of brick, heated by the escaping fire gases. In Boetius' direct-acting gas furnaces the air is heated by being passed through passages in the brick wall of the producer and other portions of the furnace. In Ireland's and in Krigar and Grothe's cupolas the blast is heated before being allowed to mingle with the products of combustion. It is only by the application of Dr. Geisenheimer's plan of using very hot blast that it is possible to burn American anthracite in the blast furnace. The functions of the deflector and the fire-brick arch now used in locomotive engines for burning coal mainly consist in heating the atmospheric air and gases for combustion. On the London, Brighton, and South Coast Railway this action is intensified by working with the ash-pan almost entirely closed up. A leading feature in Mr. T. Symes Prideaux's contrivances for economizing fuel consisted in pre-heating the air. Several contrivances of smaller fame could be cited as depending for their success on the use of more or less heated air, such as one or two forms of puddling furnaces and furnace doors. The leading feature of Mr. W. Gorman's gas furnace is that of heating the air for combustion by means of the escaping fire gases. Howatson's puddling and heating furnaces, of which a great number were said to have been set up a few years ago, is another instance of the application of heated air, as is also in great measure that of Mr. Price. A furnace which has been described as the Newport puddling furnace may be said to be on a partially regenerative system.

One obvious reason to account for the effect of the heated air in raising the intensity of combustion is the mere fact of the attendant elevation of temperature. A current of air sufficiently hot can set wood or coal on fire. But there are several more recondite reasons than this. In the first place a very high temperature of the air for combustion acts as a corrective whenever too little or too much air is introduced. The French savant Berthier gave another reason, which would partly account for several points noticeable in the practical working of furnaces. It is based on the very probable hypothesis that the chemical affinity of heated air for carbon is much greater than that of cold air. As observed by Peclet, one consequence is that when heated air is employed, it is deprived of oxygen within a very short travel. The combustion is thereby more concentrated and localized at the focus where the heat has to be applied and to do its work. At the spot required the heat is higher, and at the same time beyond it lower. These two circumstances are favorable to the economy of fuel, for combustion and high temperature beyond the point where heat has to be applied are useless. It has thus been found in practice that the greater the affinity of any fuel for oxygen the lower need be the temperature of the air. It is hence used at a lower heat in charcoal furnaces than in coke blast furnaces, and less in the latter than in furnaces fed with anthracite. This explains the fact, which has been found on trial, that a reverberatory furnace, supplied with hot air at the grate only, has actually been found to have its efficiency diminished, and not increased. The gaseous combination or chemical union being thereby accelerated, the combustion takes place more on the grate and less in the body of the furnace, where the actual work has to be done.

While heating the air for combustion intensifies the chemical affinities between the air and the fuel, the process offers another most effective means of diminishing the consumption of fuel, and of almost indefinitely increasing the intensity of the fire. By applying the fire gases—which are useless where they are only *equal* in temperature to the goods to be heated—to pre-heating the air for combustion, an actual recuperation, returning, or carrying back, of the heat is caused. This amount saved can be exactly expressed by the product of the weight of the air thus returned for use in combustion into the actual temperature given it, and its specific heat.

The exact mode of estimating this was first indicated by Mr. J. S. Prideaux, and adopted by Rankine. According to results of experiments made with the mercurial calorimeter—of course, under conditions unrealizable in practice—1 lb. of carbon, combined with its equivalent by weight, or 2⅔ lbs. of oxygen, will develop 14,500 British units of heat, or will raise 14,500 lbs. of water 1° Fah. But, to effect the combination in the atmosphere, this amount of oxygen has to be taken in conjunction with the nitrogen of the air, amounting to 9⅓ lbs. In other words, the very least amount of atmospheric air used in combustion is 12 lbs.; it is in many furnaces, especially those working with a chimney draught, required to be twice as much, or 24 lbs. Assuming the most probable case, that 24 lbs. of air per 1 lb. of carbon be taken, and that this carbon has been completely burnt, then, as atmospheric air consists of 8 parts by weight of oxygen and 28 of nitrogen, the products of combustion resulting from the 1 lb. of carbon and the 24 lbs. of air, weighing in all 25 lbs., will consist of 3⅔ lbs. of carbonic acid and 21⅓ lbs. of inert, uselessly heated nitrogen. It is clear that, for instance, the more nitrogen there happened to be mingled with oxygen, the greater the weight of matter that would have to be uselessly raised in temperature; and that the greater its capacity for absorbing heat—the greater its specific heat—the greater the amount of heat that would be taken up. We need scarcely observe that the so-called specific heat of any body is that amount of heat which it absorbs or gives out whenever its temperature rises or falls respectively; and the unit of measure in the scale of specific heat is that of water. Thus, the specific heat of carbon acid gas being 0·217 and of nitrogen 0·245, the mean of 3⅔ lbs. of the first and 21⅓ lbs. of the latter is 0·237; this, multiplied by the weight, 25 lbs., and divided into the 14,500 units of heat which can be generated from a pound of carbon, gives 2,440° as the temperature of the products of combustion in the form of about 1,800 cubic feet of fire gases. From these figures alone is seen the paramount importance of thoroughly heating the air for combustion, of thoroughly heating its oxygen in order to facilitate combination with the carbon, and of preliminarily heating its nitrogen in order that its fourfold useless volume may not rob the heat required at the very moment and focus of combustion. Now, it is evident that the nearer the temperature of the useless nitrogen is raised to that of the fire, the less is the loss to the fire in unnecessarily heating it while it is parting with the oxygen; and whatever of this can be done by means of the very escaping gases themselves is pure saving.

The very great difficulty in either heating or cooling air is its non-conducting capacity, or, more strictly speaking, the difficulty in obtaining a sufficiently rapid convection of heat to and from the mass of air employed. This is too well known to all contrivers of hot air engines or of air cooling machines; in cold climates it constitutes the comfortable properties of flannels and furs. To heat or cool air, very extensive surfaces, together with very great differences of temperature, are hence absolutely necessary. We believe that the Siemens regenerators are proportioned in such-wise as to give about 17 lbs. of fire-brick for each increment of gaseous fuels that can be developed from 1 lb. of coal. As, however, only about one-fourth of the total regenerative capacity is being heated to the full temperature of the gases passing down through the ports, this amount has to be increased fourfold; so that nearly 70 lbs. of fire-brick are probably used per pound of product of combustion. The surface of a Ponsard recuperator for an ordinary re-heating furnace is stated to average 28 square metres, half of which is for cooling the fire gases, and the other half for heating the air, and therein the air is stated to attain the temperature of 1,500° Fah. When, as in the Boetius furnace, the sides or the top or bottom of the furnace are used to heat the air, the air is, firstly, not merely heated, but, secondly, it serves as a cooling medium—protecting the brickwork by keeping down the temperature. The heat, also, that would otherwise be uselessly radiated is thus picked up by the air during its circulation, actual trials with the pyrometer having shown that the air can be heated in this way up to 600° Fah.—*Engineer.*

SLAG FOR ROAD-MAKING.

MR. BRODIE states that when soft stone is used for "bottoming" it gradually works through the harder surface and has to bear the traffic in its place, for which purpose it was never intended. Consequently the road is rendered uneven and requires much mending. It was claimed for good blast furnace slag that when the bottoming and surface layers are both formed with it, the result is a durable roadway of uniform hardness throughout and could be obtained at a less cost than the ordinary McAdam system. No foreign matter should be allowed among the slag, as it would diminish the durability of the roadway. The best slag for road making was stated to be that produced in smelting the Cleveland ore into grey or foundry iron.

DYNAMITE EXPERIMENTS.

A NUMBER of gentlemen were lately invited to the Forcett Limestone Quarries, near Darlington, England, to witness a series of experiments to show the capabilities of dynamite as an explosive for blasting purposes, fired by means of electricity, and also by fuse in the ordinary way. The first one was made on the top step or bench of rock in the quarry, into which nine holes had been bored in line, extending over a length of about 60 ft., by 6 ft. wide. These holes were loaded with dynamite, and Brain's electric fuses inserted, coupled up to each other by small copper wires insulated with gutta-percha, joined on to two main cables leading to a high tension frictional electric machine a safe distance away. All being ready, and the signal for firing given, the machine was unlocked, the cables attached to the terminals (completing an electric circuit), and by turning the handle of the machine an electric spark was dispatched along the cable through the charges, which exploded simultaneously. As the result the whole section of rock operated on was completely torn up in a most satisfactory and astonishing manner. On further examination it was found that the rock was loosened a considerable distance below the bottom of the holes; in some instances to the next bed, 3 ft. under. The next experiment was on top of the main heading of the quarry. Six holes were charged with dynamite, and an ordinary Bickford fuse, with a detonator attached, was used for exploding. These charges were fired in detail, each working very satisfactorily, the quarrymen being much pleased, as it cracked the stone very considerably, enabling them to break it up much more easily than when blasted with gunpowder, and thereby effecting a material saving of labor.

A single bore hole, about 4 ft. 6 in. deep, was then loaded with dynamite as against gunpowder, and fired in the ordinary way, the result being that the rock was well broken, and toppled over into the bottom of the quarry.

Another experiment took place in the new quarry, situated about a quarter of a mile from the other, and it having been intimated to the quarrymen that dynamite was to be used, they bored the holes in such positions as to have much more rock to operate on than they would otherwise have had, if gunpowder or any other explosive was to be used. The rock in this quarry is of a very strong and solid nature. Six holes were loaded in the main narrow heading, and exploded in the ordinary way. On examination it was found that all had operated well, one shot in particular having cut the rock in the upper bench clean across the heading, a distance of about 18 to 20 ft. Five holes ranging from 2 ft. to 4 ft. 6 in., were then loaded, and discharged in another part of the quarry, operating most efficaciously.

DR. E. VON BARY.

WE regret to record the untimely end of the well-known geologist and African explorer, Dr. Erwin von Bary, whose recent explorations have frequently been referred to in our columns. Dr. v. Bary started in August, 1876, from Tripolis, on his journey into the interior of the Sahara, supported partly by the Karl Ritter Endowment Fund, and partly by the Berlin Afrikanische Gesellschaft. The aim of this expedition was to make a thorough study of these almost unknown regions, with especial reference to topographical and geological questions, more particularly the age and formation of the great desert. The chief results of this first journey were the observations leading to the conclusion that the Sahara was not formerly the bed of an inland sea as hitherto supposed. The traveller returned from this very exhaustive and fatiguing tour to the Berber town of Chat to recruit his impaired energies, and prepare for a more extended trip into the district of the Tuarej Hoggar, which has not as yet been visited by Europeans. Here he met the sad fate of so many African explorers, and died on October 2, from the effects of excessive exposure and privation. Von Bary's varied qualifications and complete devotion to the cause for which he perished, had led to high expectations among his fellow German geologists, and a general feeling of regret is felt over his early death, away from home and friends. The French geologist, M. Largeau, is at present endeavoring to penetrate into the Tuarej region from the north, and the interest previously centred on von Bary's investigations will now gather about his efforts.

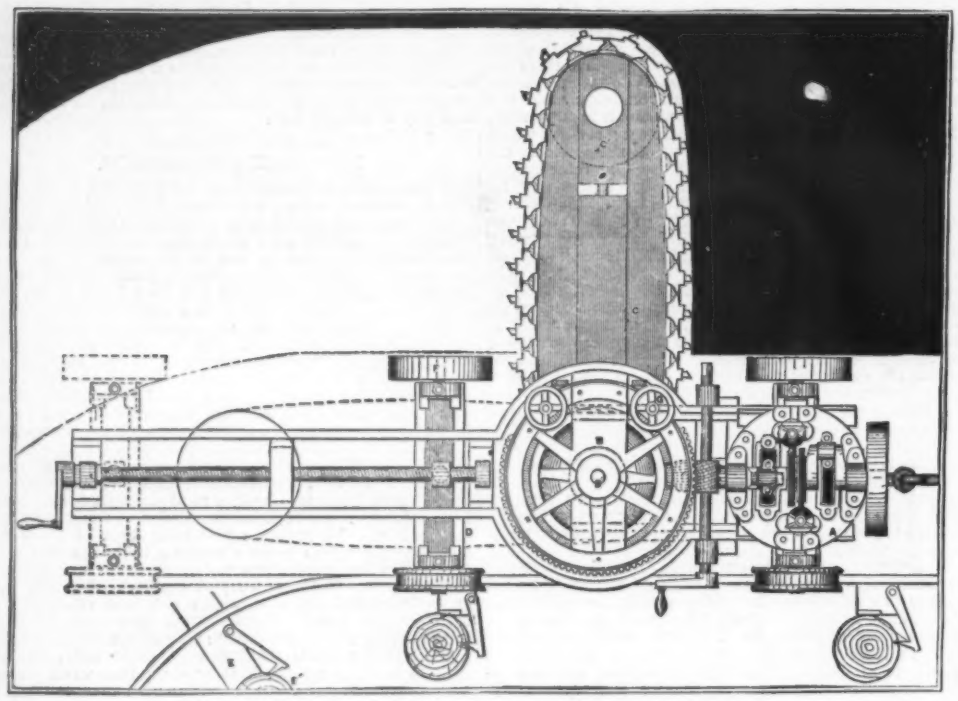
RECLAIMING A LARGE SWAMP.

BLISS SUTHERLAND, of Kankakee, Ill., is engaged in digging a ditch seven and a half miles long, from an eight thousand acre tract of swamp land in Newton County, Ind., belonging to Gaff, the Cincinnati brewer, to the Iroquois River, in the northeastern part of Kankakee County, Ill. The ditch will be eighteen feet wide at the bottom, thirty feet wide at the top, and will be four feet deep. At one point in its course, where it intersects a sand-ridge one thousand feet wide, the ditch will be eight feet deep. Six miles of the distance is traversed after leaving Mr. Gaff's land. Besides this immense outlet, there will be thirty miles of ditching done on the eight thousand acres. The work will keep fifty to a hundred men employed all next season, and the cost will be over $20,000. At a cost of $4 per acre the land can be made worth $30, where it is now worth $2 or $3.

ACCORDING to a Belgian photographic journal Herr Zinno has discovered a new way of preparing oxygen in large quantities. Baric peroxide and potassic permanganate are placed in water and allowed to act upon one another, the result being that 200 cubic centimetres of oxygen are evolved from every gramme of the mixed substances.

IMPROVED COAL-CUTTING MACHINE.

THE accompanying engraving represents a plan view of one construction of what is known as the "Monitor Coal Cutter," under the patents of Horace F. Brown. This machine was designed and built especially for the Fall Brook Coal Company's mines at Antrim, Tioga Co., Pa., where it is now in successful operation. It is especially adapted to that class of mines where the undercut must be made directly on the bottom, or within a few inches of it. Among other difficulties in the way of coal cutting by machinery is the



IMPROVED COAL CUTTING MACHINE.

varied formations in different coal measures, and so great is this variation that it has been found impracticable to meet all cases with one construction of machine.

The first machines under these patents were built for the block coal regions in Indiana, and worked in the mines of Niblack, Zimmerman & Alexander, at Brazil, Clay County, Indiana. In the upper vein the mining was made about one foot above the bottom, while in the lower vein the best results were obtained by mining one foot from the top, or at a height of 2 feet 6 inches to 3 feet 6 inches. In the Fall Brook mines at Antrim, and in all the surrounding coal measures embracing the "Blossburg" regions, it is necessary to make the undercut directly on the bottom. Nearly all the mining in this country is done by means of driving up narrow ranges and leaving alternate pillars to support the roof, and any machinery to mine successfully must be so constructed that it can be readily removed from one range to another, and in fact portability and adaptation to the mines are features of as paramount importance as the cutting machine itself.

In the machine under consideration all these requirements are combined. A shows the inner and supporting part of the cutter arm; this is joined to the frame D by means of a pivot hinge that holds the arm horizontally, but allows it to be raised or depressed on either edge, by means of which the cutter can be made to lead up or down in the coal, to follow the irregularities of the bottom, to avoid interlaminated strata of rocks, etc. The arm can also be raised or lowered without otherwise changing its relative position to the machine. B is the outer portion of the cutter arm, and is grooved to A in such a manner that it can be thrown out or in to lengthen or shorten the arm as required. Attached to B is the wheel C, that acts as a carrying wheel for the chain E at the outer extremity of the arm: at the other end of the arm, and attached to the shaft L, is a similar wheel that acts as a driver for the cutter chain. F is a double cylinder vertical trunk engine, 8 inch bore and 7 inch stroke. The whole is attached to the framework J. This, in turn, is supported by the wheels G, H, etc. The wheels are all plain flanged wheels, as shown by G. While working, the machine requires but one rail of the common T iron, nine lbs. per yard. The forward wheel is kept on the rail by means of the second flange G', which is slipped on and held by means of thumb screws. The other two wheels are rimmed into the broad flanges H, made in two or more sections, which run directly on the bottom. When in shape for moving, the wheels G H are drawn to the end of the flange J by the screw K, and the cutter arm swung under the frame J by means of the screw shaft D', which engages the teeth of the segmental gear attached to the frame D.

The machine is fed forward by means of a power windlass, operated by air. The windlass consists of an upright drum, driven by a small rotary engine, so geared that it will wind slowly enough for the lightest feed or fast enough to pull the machine up the grade from the gangway very rapidly. The feed can be varied instantly by the throttle valve to suit the varying strata that are being cut, and from the fact that in many places in the same breast one yard can be cut in half the time with the same power that it would require to cut the next yard.

The capacity of the machine, of course, varies greatly with the nature of the material cut. The following table will show what the machine is doing daily in what is about the average hardness of splint coal:

Weight of machine	3,800 lb.
Depth of cut (extreme)	4 ft.
" " (average)	3 ft. 6 in.
Thickness cut out	2 ft. 6 in.
Pressure used per square inch	25 lbs.
Cut along face (av.) per hour	20 yds.
Space between props and coal	42 in.
Gauge of track	20 in.

Exceptional work, 15 yards in 20 minutes; 30 yards in 55 minutes; 5 yards in 4½ minutes.—*Engineering and Mining Journal.*

IMPROVED SPEED INDICATOR.

THIS instrument is one designed not to act as a counter merely, but, and what is often of far greater importance, to reveal by a glance at a needle, and without counting or using a watch, the speed at which an engine or a machine may at any moment be working. We illustrate the front elevation of the apparatus in Fig. 1, and a vertical section in Fig. 2. Referring to the sectional view, the small pulley B is driven by means of a quarter-inch round band from another pulley of suitable size placed on the shaft whose speed is to be indicated. The pulley B drives a small shaft A, on which is fixed, inside the casing, a small fan with radial vanes C. Close to, and alongside of this fan, is placed another one D, very delicately mounted on a small steel spindle which carries, but outside the fan box, the indicating needle E, which works on a dial in the usual way. The spiral spring F, seen more clearly in Fig. 2, always tends to bring the needle to the zero of the instrument, which, of course, is the lowest speed it is intended to indicate. When the fan C is caused to revolve it has a tendency, on account of the air enclosed in the casing, to carry round in the same direction the fan D, together with the index needle E, and that against the resistance of the spiral spring F. The greater the rate of revolution, to a greater extent is it possible for the fan D to overcome the tension of the spring, and the further round will the needle be carried. The needle and fan are brought to rest as soon as the pressure on the fan vanes is balanced by the resistance of the spiral spring, the needle, of course, then indicating the increased velocity. The dial of the one we represent is indexed for every revolution per minute from 25 to 50; but by means of the eye the divisions may be subdivided to a quarter revolution, or even to an eighth.

The spring admits of being easily and rapidly adjusted, so that the indications may be between wide limits of speed, it being only necessary to place on a fresh dial; or, if it is of greater moment the adjustment may be made so that the indications of speed may be confined to a narrow range, but that small variations may be noted with great certainty and accuracy.

By means of holes provided in the back of the case, the attachment of the instrument to the bracket may be such that the latter can, if required, be secured to the ceiling, to a vertical wall, or fixed on a table as shown.

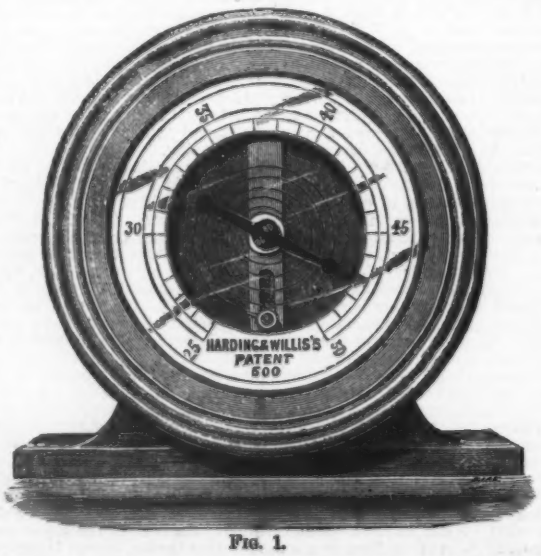


FIG. 1.

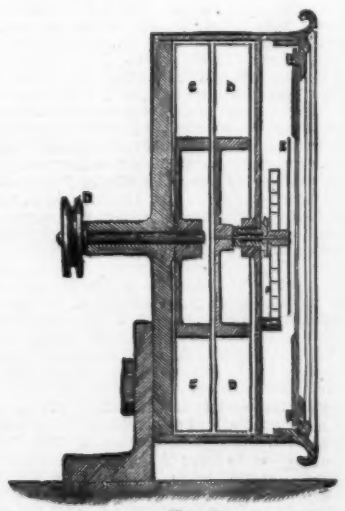


FIG. 2.

HARDING & WILLIS.—IMPROVED SPEED INDICATOR.

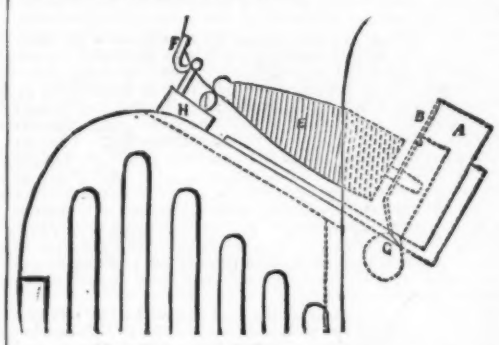
As will be seen, the whole thing is very simple; and as the working parts are thoroughly boxed in, and so protected from dust, etc, the liability of its getting out of order must be very small. The manufacturers are T. R. Harding & Co., Tower Works, Leeds, Eng.

IMPROVED WINDING MACHINE.

WE have recently had the pleasure of inspecting an improved winding machine, adapted for winding cotton, wool, linen, silk, or any description of fibrous materials. Primarily, cotton is the article for which it has been chiefly designed, and the pirn bobbin of the ring spinning frame is the base of the invention. It is, however, by a slight modification, equally applicable to the winding of twist cops. Mr. Luke Scott, maker, of Rochdale, Eng.

The objects of the invention are to supersede the use of spindles in machinery for winding and reeling various descriptions of yarns; and to obtain increased speed of working, with decrease of cost in the manufacture of the frames, and a lessened consumption of oil for lubricating purposes: the sum of all being a considerable economy in the process of winding.

In our illustration, which exhibits a sectional view of the machine, or rather of the improvements, the means by which it is sought to effect the above purposes will be easily seen. To an ordinary winding frame, or reel, the inventors fix, longitudinally, a horizontal rail of wood, or other material, A, to which are fixed the single halves of hinges, levers, or springs, B, the second halves hanging, and working freely, in the fixed portions. To these latter are attached taper pegs for carrying the bobbins, or cops, which, by means of the hinges, can be moved from the oblique position occupied while the machine is working, to the vertical state, so as to facilitate doffing the empty pirns, and replenishing the machine with another set of full ones.



When in the oblique, or working position, the point of the bobbin, E, rests or rather presses, in a cavity in a horizontal bar of metal, attached to the wood bearer, H, this pressure being insured by means of weights hung on the lower halves of the hinges. This pull of the weight, or spring, would, of course, bring the pirn to a horizontal position, were it not for the obstruction offered to it by the bar. The yarn, in process of winding, passes under the points of the pirn bobbin in contact with the bar of iron, and through the guide wire, F, to the bobbin on which it is being wound. The draught of these bobbins upon the yarn contained upon the pirns overcomes the pressure of the latter upon the iron bar. The yarn is thus consecutively interrupted in its delivery to the bobbin. This successive check has a remarkable effect in cleansing the yarn from leaf, seed-shell, motes, loose fibre, and other impurities. This is a great advantage, especially in working the lower number of yarns, which are frequently unclean. It has another effect hardly less useful—that of taking out all "single," and soft portions of the threads as well. The yarn is also kept perfectly free from "snicks," "snarls," or "kinks." The advantages thus obtained are very distinguishable in subsequent processes. The warper gets along with much less interruption; produces more work, and of a better quality; and when in this clean state the yarn has passed through the sizing process, and gets to the loom, the sum of all the improvements is seen in the production of a clean, smooth cloth, free from all roughness and harshness to the touch ordinarily found in cloth made from low numbers of yarns. The machine admits of a much greater speed being applied to it than can be used with the ordinary winding frame. In itself it thus becomes more productive, and more effective, and is the cause of greater efficiency, and an increased out-turn in the subsequent stages, and, *plus* all these merits, an improvement of the quality.—*Textile Manufacturer.*

HISTORY AND ART OF DYEING.

MR. G. HOLDSWORTH recently delivered a lecture at Kidderminster on this subject, and in the course of which he stated that dyeing dates back from time immemorial, and seem to have been practised by the Persians, Syrians, Egyptians, and natives of East India. We find frequent mention in the Pentateuch of linen cloths dyed blue, purple and scarlet; of rams' skins dyed red. The works of the Tabernacle, the badge of royalty. So highly prized was this color, that in the time of Augustus a pound of wool dyed with it cost, at Rome, a sum equal to £30. The Tyrian purple is now generally believed to have been derived from two different kinds of shell-fish, described by Pliny under the name of *Purpura* and *Eucumia;* only one drop being obtained from each fish. After the goods were immersed in this liquid its development was peculiar; first it was colorless, next citron-yellow, green, azure, red, and in the course of forty-eight than 200 establishments at work early in the fourteenth century. It was a Florentine dyer who found out the lichen from which archil, cudbear, and litmus are made, and who acquired by its sale an immense fortune.

The discovery of America tended very much to develope dyeing, as many new dyes were added—such as logwood, quercitron, Brazil-wood, cochineal and annatto. About the year 1650, another improvement was made by the discovery of salts of tin, which, with cochineal, produce a most bril-

SUGGESTIONS IN DECORATIVE ART.—MAJOLICA TILES; FROM THE ORATORY OF S. CATARINA IN SIENA.

From the Workshop.

and the vestments of the high priest, were commanded to be of purple. The Tyrians were probably the only nations of antiquity who made dyeing their chief occupation and staple of their commerce. The opulence of Tyre seems to have proceeded in a great measure from the sale of their rich and durable purple It is unanimously asserted by all writers that a Tyrian was the inventor of the purple dye, about 1,500 years before Christ, and that the king of Phœnicia was so captivated with it that he made purple one of his chief ornaments, and for many centuries after Tyrian purple was hours a brilliant purple. We now dye a purple of greater brilliancy, but lacking durability, for, say, 1d. per pound. In ancient Greece it does not appear that the art of dyeing was much cultivated. IN ROME it received more attention, although the art was held there in very low estimation, and that progress in dyeing was completely stopped in Europe for a time by the invasion of the Northern barbarians in the fifth century, and did not revive again till towards the beginning of the thirteenth century. One of the places celebrated for this art was Florence, where it is said there were no less liant color. Logwood and indigo began to be employed about the middle of the sixteenth century, but not without considerable opposition from the cultivators of the native woad, which is now prepared in Lincolnshire, and employed along with indigo for preparing what was known as the "woad vats," used most extensively in Yorkshire, for navy blues and all blues of similar character. Logwood and indigo were prohibited in England by Queen Elizabeth under a very heavy penalty, and all that could be found in the various dye-houses in the country was ordered to be destroyed,

and their use was not permitted in the reign of Charles II. Indigo at the present time is one of our principal dyes. It is a native of India, although it is cultivated in many tropical countries. A considerable trade is done in Bengal, from whence we get such large amounts. It was denounced as "food for the devil," and forbidden by Parliament, and this Act remained in force for the greater part of 100 years. When these prejudices were overcome in the eighteenth century, dyeing made remarkable progress. To the Indians we are indebted to the discovery of Turkey red. The following is a Swiss method for 440 lbs. cotton, 29½ lbs. fat oil, 55 gallons of carbonate of potash, 13½ gallons of cow dung, fermented and brought into a pulpy state with cow urine (the above is repeated four times), 117½ lbs. oil, 220 lbs. carbonate potash, 55 lbs. cow dung, 16½ lbs. gall-nuts, 14 lbs. Silesian sumac, 47 lbs. alum, 77 lbs. c. potash, 50 lbs. madder, 6 lbs. sumac, 374 gallons ox-blood, 11 lbs. soap, 66 lbs. chloride of tin, 200 lbs. nitric acid. The time was, in some instances, two months. We can now dye a corresponding color in two hours on woolen.

Without going into abstruse chemical equations and formulas, which undoubtedly would be most invaluable to all dyers if they possessed a sufficient knowledge of chemistry, it must be said that if the chemist and dyer could assimilate or mix up their ideas more, great advantage would result, and were the dyer's knowledge combined with thoroughly correct and scientific chemical information, the British dyer need not be ashamed nor fear any rival from foreign countries. Although it must not be inferred that every chemist is a dyer, every dyer ought to be a chemist. It has often been asked, will reading and understanding chemistry make any person match colors any better? No; but it gives the knowledge what chemical phenomena takes place when certain stuffs are put into a vessel; it would also suggest and assist in producing new colors, which it is impossible to do without chemical knowledge. The fact is, the non-chemical dyer must always play second fiddle, and that fact alone must be very annoying to a sensitive man. We must all admit that whenever a new dye comes out (and their name is legion), it comes from the chemist. Chemistry would also suggest methods of altering any shades that have gone wrong in dyeing (and that very often takes place with the best of dyers), which is a most important and expensive item to manufacturers, for such colors are very often consigned to the black furnace, which means in the case of a cochineal red—say 6d. per lb. dyeing, and the yarn of a much better quality than blacks are dyed from; then the same expense takes place in dyeing black as though it was fresh-scoured yarn. Hundreds and thousands of instances as above have happened through the dyer's inability to make the necessary alteration.

Now one most important and vital consideration in dyeing is good and pure water, as upon its goodness depends the probability of good and lasting colors. It may be mentioned that the impurities of water are carbonates of lime, magnesia, iron, sulphate of lime, etc. The water most suitable for dyeing must fulfill the following conditions: It must not be too hard; it must not deposit a brown sediment of oxide of iron when freely exposed to the air for some hours, nor must it show anything of a blue nature when a few drops of a solution of red or yellow prussiate of potash is introduced into it, which shows a presence of iron. Every dyer should be strongly recommended to have a little litmus paper by him—turmeric and archil—the turmeric litmus paper is the most sensitive to alkaline properties, turning it brown, and the archil litmus turns somewhat red in acids. It may be tested with some degree of accuracy by putting into it a little logwood, and making a similar test with distilled water. When it boils it ought not to throw up a reddish brown scum of oxide of iron. Another and most simple test is to dye samples with distilled water, and afterwards ordinary dyeing water; and if results are about the same its suitability for dyeing purposes may be relied on.

Another most important item in obtaining good and solid colors is scouring. Unless your material to be dyed is free from dirt, grease and fatty acids, you cannot expect good results. Now, a great many articles are used for scouring, such as soap, soda, ammonia, urine, caustic soda, resin, pearl ash, and many more, and it is hard to say which is best. Some say one, and some another, and further scouring naturally affects the colors according to method; but in all cases wash out the yarn in lukewarm water, before dyeing, and let the yarn drain.

It may be mentioned that colors, as a rule, are dyed with a due regard to fastness, according to where and what material they have to be worked into. For instance, the Kiddermінster method of dyeing would not, for one moment, do for the cloth or West of England trade. And one class of shades which occupies no unimportant part of carpet manufacturing is the drab, which in cloth is more solid and much cheaper.

TO DYE SILK WITH ANILINE GREY OR BENGALINE.

BENGALINE has for some time been playing an important part in silk-dyeing. It is used to produce a number of good greys, modes, deep blues, dark greens, etc. These colors are not appreciably more expensive than similar ones produced with dye woods, and the same beck may be used over again for a long time. An old soap-beck may generally be used, with a little sulphuric acid, and the tone of the color may be modified in an almost endless manner by the addition of a little orchil, young fustic, etc.

For heavy greens turmeric may be used in the same beck along with the grey, and some aniline blue, and they may be afterwards raised by being taken through picric acid. For so-called "marine blues," a mixture is taken of bengaline and aniline grey. The largest manufacturers of aniline grey and bengaline are A. Schlumberger and MAX SINGER, of Tournai. Bengaline is dissolved in the manner usual for aniline colors, and it is well to filter alcoholic solutions.

To make up the dye-beck take for each 2 lbs. 3 ozs. of silk, a pail of the old soap liquor used for ungumming, add 2½ ozs. of sulphuric acid, heat to 140 deg., and then enter the dissolved color and the silk. Raise the temperature to a boil. Afterwards rinse well.—*Teinturier Pratique.*

PRINTING WOOLENS A COCHINEAL RED.

By M. KIELMEYER.

COCHINEAL reds are obtained upon wool in printing by a mixture of a decoction of cochineal, salt of sorrel, salt of tin, oxalic acid, and a thickening; or for decoction of cochineal, or salt of tin, we may substitute a tin lake of cochineal. The acidity of these mixtures gives to the color of the cochineal a yellowish tone, which remains after soaping, or after passage through lime-water, if the pieces are to be steamed. The author remedies this inconvenience by the addition of acetate of soda. In the cold this admixture is without effect, but, when heated, the acetate of soda acts as an alkali, and loses its acetic acid under the influence of the oxalic acid, which thus becomes neutralized. The color obtained presents a warmer and redder tone; although in appearance less full, in reality it is less brown. If a yellow tone is desired, it is better produced by the addition of a yellow coloring matter than by a change due to the action of a free acid. The author prefers the following formula:

Gum	14 parts
Water	15 "
Cochineal lake	17½ "
Young fustic lake	2½ "

Heat to 140° Fahr., and when the gum is dissolved, add:

Oxalic acid	1 part
Pure salt of sorrel	1¾ "
Acetate of soda	2½ "

After printing, dry at a gentle heat for one or two days expose for an hour to very hot steam, dry, wash, and dry again. The shade obtained is very like that yielded by a corresponding dye-beck.

The addition of acetate of soda gives much purer tones in steam yellows and oranges with fustic, and especially in magentas upon cottons.—*Dingler.*

THE COCHINEAL REDS UPON WOOLEN TISSUES.

By M. KIELMEYER.

The author recommends an addition of acetate of soda to the colour to counteract the effect of the cochineal. He prefers the following mixture:—

Gum	14·0 kilos.
Water	15·0 "
Cochineal lake	17·5 "
Young fustic lake	2·2 "

The mixture is heated to 60°, and when the gum is dissolved there is further added—

Oxalic acid	1·00 kilo.
Pure salt of sorrel	1·75 "
Acetate of soda	2·25 kilo.

He adds that the addition of acetate of soda greatly improves the tonic of the steam yellows and oranges produced with young fustic. The benefit is still more signal in printing cottons with magenta.—*Dingl. Pol. Jour.*

IMPURITY OF THE GRANULATED WHITE SUGARS OF THE MARKET.

By EDWARD RUNYON, New York.

It was found on comparison that the several brands of supposed A No. 1 granulated sugars of the market produced syrups of different tints, which suggested an examination of their quality.

Samples were found containing a considerable proportion of ultramarin, which after several days' standing was deposited. Syrups made from sugars having the ultramarine impurities are discolored, being usually of a pale straw color.

This adulteration and additions of sulphate of tin, alum, etc., are used by refiners in the interest of dollars and cents, and are designed to neutralize the yellow tint in imperfectly refined sugars. The practice is known among refiners as adding the complementary color.

Unquestionably ultramarine adulteration is chemically injurious, being decomposed by fruit or organic acids with evolution of sulphuretted hydrogen, which produces a disagreeable taste; aside from this serious objection, the officinal syrups, instead of being colorless and bright, are tainted and dull in appearance. Pure sugars can be had by purchasing from first-class manufacturers, and paying a slight advance on the price of ordinary marketable granulated white sugar.—*Am. Jour. of Pharmacy.*

WHY MILK SOURS DURING THUNDERSTORMS.

By MALVERN W. ILES, Ph. D.

THERE have been various surmises with regard to this subject; none, so far as we have been able to learn, have been substantiated by experiments.

In order to see if milk really did sour during heavy rain and thunderstorms, I made several observations which proved to me that the opinion so commonly held by dairymen was not erroneous.

My experiments to arrive at the cause of the phenomena thus observed may be stated as follows: I filled an eudiometer tube (300 c.c.) with skimmed morning's milk, then introduced 100 c.c. pure oxygen gas; then, by the use of an ordinary battery and a small Ruhmkorff coil, sparks of electricity were made to pass through the oxygen for five minutes. The current was then broken, the tube shaken up, and allowed to stand for five minutes. The milk did not appear quite so opaque, and showed a noticeable acid reaction. On continuing the current for five minutes longer, making in all ten minutes, the milk curdled very perceptibly, and showed a decided acid reaction. The contents of the tube, on standing for twenty minutes, had reached the consistency of ordinary sour milk, or "bonny-clabber."

From the above experiments it will be seen that the oxygen was converted into ozone, which we think may be stated as the cause of the rapid souring of milk during thunderstorms.

The increased acidity is due to the formation of lactic acid, and most probably some acetic acid, by means of the ozone, one or both of these acids thus causing the casein to be precipitated.—*Chemical News.*

JEANNOTTE makes use of the following process for replacing indigo by aniline in dyeing animal and vegetable fibres, whether woven or not. The essential feature of the process is the oxidation of the salts of aniline in a very dilute bath in contact with the goods to be dyed. The following is a specimen formula for cotton: Aniline, 5 parts; muriatic acid, 3 parts; sulphuric acid, 12 parts; bichrome, 5 parts. The muriate of aniline is first prepared, the bichrome is then dissolved separately, and the whole is diluted with 1,000 parts of cold water. The cotton is worked for about an hour, then washed and taken through a slightly alkaline beck at 104 deg. Fahr. To give solidity to the indigo-blue shade obtained it is well to top the goods slightly with an aniline blue, or, better still, to take them through a weak indigo vat.

IT is said that India is not favorable for the growth of Sea Island cotton, and this statement is based apparently on practical experience.

OPEN AIR FOR CONSUMPTIVES.

By H. B. WHITE.

PURE air is the great desideratum, either as the chief therapeutic agent, or as of equal importance to any other in the treatment of any disease.

This truth is recognized now by all members of the profession, more or less, though the popular mind does not yet seem to realize that it is of the greatest vital importance. There has been great advance in therapeutics within comparatively a few years, but in no direction has there been more improvement than in the recognized importance of *fresh air* for the preservation of, and restoration to, health in the animal economy. The time was, and that too within the memory of very many members of this Society, when fresh air was considered very well for healthy people, for they could stand it, but physicians were cautious about exposing their patients to its deleterious effects, especially those suffering with fevers and kindred zymotic diseases. How often have I seen in such cases the windows securely caulked, and the door of the sick chamber carefully guarded, to prevent the slightest breath of pure air from reaching the patients! It was considered too strong for them. The bare thought that such a state of things was ever possible may well create astonishment in the minds of some here who have been educated under a better hygienic system, but we are still liable to meet just such murderous practice, and called upon almost daily to combat the prejudices of not only the ignorant, but educated people, against the admission of this best of all therapeutic agents into the sick room.

But a few years ago a case came under my notice, illustrating this ignorance and prejudice: A lady, in excellent health, confined with her first child, labor natural and easy, everything seemed to promise a speedy restoration to her normal condition of health and strength.

By orders of her physician, the windows of her room were secured against the intrusion of fresh air, and the door so carefully guarded as to admit the least possible amount of air with the necessary entrance and exit of her nurse. As a consequence of such treatment, digestion became impaired, appetite failed, mammary abscesses on both sides followed one after another, with no disposition to heal, and instead of gaining strength, or even retaining what she had, she continued to lose ground, and was for months unable to leave her room. It did not require an acute observer to to lay the blame of all this misery upon the exclusion of fresh air. Not many physicians are thus groping in an unhealthy atmosphere. Thanks to scientific progress, sunlight and pure air are recognized as remedial agents in the maintenance of good health, and in the cure of disease. We can now open doors and windows and "throw physic to the dogs," without risking a charge of malpractice.

One of the standing jokes upon our profession, viz.: the oft-told story of the doctor congratulating his patient upon his improvement by remarking that he must have followed his prescription, and getting for answer, "If I had, I would have broken my neck, for I threw it out of the window," may be turned to good account by the supposition that he forgot to close the window as the medicine went out.

My object in this article is to emphasize the proposition that the more we learn to rely upon the stimulating, invigorating effects of pure fresh air, the less we will care for drugs.

But in many cases it is not sufficient to simply open the doors and windows of the invalid's room to give him the benefit of absolutely pure air. It cannot be had in our houses, even in the best constructed and the most favorably situated for free ventilation. Neither can it be found out of doors, in the streets of our crowded cities. We all see the immediate beneficial effects of a change from Brooklyn to Coney Island for our little patients suffering with cholera infantum. To what is it due? Not to a change of climate, for that is the same; not to the sea air, for Brooklyn has that; but to the change from the impure air of the city to the pure air that comes sweeping in from the ocean.

How we watch our patients' stomachs, carefully direct the quantity and quality of their food, note the slightest symptoms of indigestion, yet the condition of the air they breathe is of vastly more importance. The purity of the blood depends more upon it than the food we eat. The source of a majority of the diseases that afflict the human family and destroy life, is found in the deadly miasms that float unseen in the atmosphere all around us, and which we unconsciously inhale in our very efforts to live. In the midst of life we are indeed surrounded by death. Every man consumes daily four pounds of oxygen, and exhales from the lungs a much greater weight of carbonic acid. Besides this, animals constantly exhale from their bodies effluvia highly poisonous and deadly. Also from the soil-pipes of our houses, and the gutters and sewers of our streets, emanates the morbific principle, zymosis, which rapidly spreads through the air, and proves so fertile a source of disease. In view of all these considerations, how important is it that we seek every possible means of obtaining pure air in the prevention and treatment of disease!

Our late war furnished abundant opportunities for verifying the wisdom of this practice. Our hospital barracks were well constructed to secure good ventilation—much better in this respect than our modern houses. The open ridge the whole length of the building, the open window by the bedside of every patient, to say nothing of the many openings left by hasty, careless construction, would certainly seem to furnish all that was desirable in that direction. But experience soon proved that there was purer air out of doors, and if the fever took an unfavorable turn, or the wound assumed an unhealthy aspect, the patient was ordered into the open air, with only the roof of a tent for his covering, when his condition would almost invariably improve at once. But my purpose now is to speak more particularly of the necessity of *open air* in the treatment of consumptives. I am aware that in this there is nothing new; and that I run some risk of meeting your disapprobation for taking the time of the Society in discussing a method of treatment so generally recognized as correct. Yet I think it is not sufficiently insisted upon, especially for the prevention of this disease, and in the treatment of the early stages, when it promises the most benefit. I hold that if a patient cannot leave home to enjoy the beneficial treatment of out-door life in a climate suited to his case, he must seek it in our climate, with all its changes. Dress suitable to the weather, and be out all of the time, no matter what the meteorological conditions, should be the advice given to consumptive patients who are able to be out at all.

The universal testimony of scores of persons who crossed the Plains, mostly on horseback, during the years 1850 to 1856, attributed their recovery from incipient phthisis to

those months of enforced living in the open air. These emigrants rarely had sufficient covering at night for the whole party, and most were obliged to sleep in the open air. Often drenched with rain, and suffering many privations, yet the delicate and sickly did not break down, as they feared, but at once commenced to recuperate, arriving in California strong and healthy

Our climate, owing to the sudden changes of temperature and cold east winds, is undoubtedly most unfavorable for the full benefit of this special treatment, therefore a change of residence is desirable, and often the only thing that will be of any avail.

Must I leave home? When? Where shall I go? How long shall I stay?—are questions of momentous importance, which are referred to the family physician for his decision. Florida affords the best climate, and offers the best inducements of any place this side the Rocky Mountains; but one serious objection to the climate of Florida is that it is not suitable for a permanent residence. Patients should seek a climate suited to out-door life the year round, and remain at least three or four years, or until the tubercular cachexia is overcome, or a cure of the already established disease is effected. It is because patients neglect this simple precaution that such very slim results are obtained by change of residence. Even the winter climate of Florida—certainly in many parts of the State resorted to by consumptives—is too changeable for a comfortable out door life at all times. At St. Augustine, a place of frequent resort, a daily range of thermometer of 40° is not unfrequent, and cold storms from the ocean necessitate the lighting of fires.

One writer says: "Invalids, who spend the winter months at St. Augustine, are often prevented from venturing into the open air by the chilly northeast blast, surcharged by fogs and saline vapors, which sweeps down the coast from the northern latitudes."

The same objection, however, does not apply to some of the inland towns.

At Aiken, S. C., during some portions of the year, the climate is all that could be desired, but the summer months are unhealthy, and even in winter the diurnal range of temperature is too great for invalids to remain constantly out of doors.

Dr. Felix L. Oswald, in the *Popular Science Monthly* for Nov., 1877, says: "That low temperature in open air does not injure our lungs is conclusively proved by the fact, that of all nations of the earth, next to the inhabitants of the Senegal Islands, the Norwegians, Icelanders, Yakuts of Northern Siberia, enjoy the most perfect immunity from tubercular diseases." And to show that it is not cold alone that arrests the tendency to these diseases, he says: "In Great Britain the (death) rate (from consumption) increases with the latitude, and attains its maximum in Glasgow, where windows are opened only *one* day for every two in Birmingham, and every three and a half in London. But further north," among the shepherds and farmers, "the percentage suddenly sinks from 23 to 11, and even 6 if we cross the 57th parallel, which marks the boundary between the manufacturing counties of Central Scotland and the pastoral regions of the North." Again he says, that the natives of Senegambia (Africa), pulmonary affections are not only *nearly*, but absolutely unknown. Again, he quotes Langenbeck, the great anatomist, as saying, "that pulmonary diseases have very little to do with intemperance or erotic excesses, and much less with cold weather, but are nearly exclusively (if we except tubercular tendencies inherited from both, I say *quite* exclusively) produced by the breathing of foul air."

Our object, then, should be to find for our patients the climate so mild that their lives may be passed in the open air.

In the Hawaiian Islands we have such a climate, which, in its average temperature and in equability, may be said to be perfect; where consumptives can literally live in the open air without fear of those sudden changes so objectionable in nearly all the noted "retreats" for invalids.

These islands are situated between degrees 10 and 22 north latitude, in the region of the trade winds, which blows with great regularity about ten months of the year. Although lying within the tropics, where the heat might be expected to be oppressive and debilitating, the temperature is so modified by the constant fresh breezes coming over the wide expanse of ocean, that it does not appear to be so great as the thermometer indicates.

Says the historian, Jarves: "The climate is everywhere salubrious, and possesses a remarkable evenness of temperature, so much so that the language has no word to express the general idea of weather. Physiologists give a certain point of temperature as most conducive to health and longevity. The mean heat of these islands approaches near to it, and is highly favorable to the full development and perfection of the animal economy." Again, when speaking of certain localities as favorable for consumptives, he says: "Many individuals, by change of residence, have prolonged their lives for years, and others live with scarcely an admonition of their disease, who, in less favored regions of the North, were perpetual sufferers."

The most favorable situations for such patients are Honolulu, on the island of Oahu, Lahaina and Ulepalekua on Maui, Kailua on Hawaii, and Ewa on Kauai, as these places have the best temperature for constant out-door life, and afford comfortable residences for invalids.

The mean temperature on or near the coast of all the islands is 75°, with but little difference between summer and winter—it being 79° for the warmest months and 73° for the coldest, showing a difference in mean temperature of but 7°.

During an observation of twelve years at Honolulu, the maximum of heat was 90°, and the minimum 53°, a difference through that long period of but 37°.

At Lahaina, during an observation of ten years, the highest register of the thermometer was 86°, and the lowest 54°, a difference in one decade of only 32°.

But a range so great as that is very unusual. During my residence at Lahaina of four years, the maximum was 84°, and the minimum 61°, while the general average for the summer months was 82° at midday, and about 72° for the winter months.

During a daily observation of four months, in 1858, between the hours of 9 A. M. and 5 P. M., the thermometer did not vary 1°, but remained almost absolutely stationary. The usual diurnal range at Lahaina is between 1° and 4°, and at Honolulu a little more—viz., from 3° to 6°. At Honolulu the average rainfall is 30 inches. The average number of fine days is 285; rainy days, 37; variable days, 43. At Lahaina there is less rain-fall, and more fine days, owing to the conformation of the island at that place. The town is situated on the leeward side of the mountains, which rise 6,000 feet above the sea, intercepting the trade winds, and condensing the moisture of the air upon their tops, so that but little rain falls on the plain below. In 1860 we did not have a shower for eleven months, and there were really more than 340 fair days. Whenever the trade winds are intercepted, as at Lahaina, there is a constant and most refreshing land and sea breeze.

By ascending the mountains a few miles inland, almost any degree of temperature can be obtained. The top of Mauna Kea, on Hawaii, more than 14,000 feet above the sea, is often covered with snow. Waimea, Hawaii, 4,000 feet above the sea, is a favorate resort for enervated constitutions, as the average temperature is 64°–48° being the lowest. On the table lands of Kauai, at an elevation of 4,000 feet, warm garments and fires are required as well in July as in December. If the climate of Lahaina is found too warm and enervating for consumptives, an average temperature of about 70° Fahrenheit, and very equable, is found at Ulepalekua, Maui, about two miles from the coast, and at an elevation of about 2,500 feet. Although more rain falls than at Lahaina, most of the time the weather is delightful, the atmosphere dry, clear, and bracing, proving to the invalid most agreeable and invigorating.

In 1857 I was called to Ulepalekua to visit a gentleman from New York, who had arrived about a year before in the advanced stage of phthisis pulmonalis. He described his condition previous to coming to the islands, as precarious in the extreme—viz., constant and harassing cough, copious, purulent expectoration, difficulty of breathing, emaciation, night sweats, and great debility. He soon commenced to improve, and when I saw him, cough and expectoration were much less, weight was good, and strength increasing.

Physical examination showed very extensive disease, percussion giving marked dulness over all the left, the apex of the right lung, and auscultation revealing broncephony, with cavernous respiration, on the left side, and bronchial breathing, with more or less rales, on the right side. There was no normal respiratory murmur, except over the middle and base of right lung. It was altogether a most hopeless case to expect much benefit by a change of climate. But the disease seemed to be arrested. He was much in the open air, on foot or horseback, and really enjoyed life again for the four years he remained. Considering his health sufficiently re-established to warrant it, he left the islands, and died at New Orleans on his way home.

Several of the missionaries and other foreigners went to the Islands predisposed to phthisis, and some even in the more or less advanced stages of the disease, yet all recovered health, and ever after enjoyed immunity from this dreaded scourge of colder climates.

Many of the descendants of these early families, to the third generation, still reside there, but with my four years' residence, and pretty extensive acquaintance, I don't remember to have heard of *one* who had ever suffered with phthisis pulmonalis. In fact, to foreigners, and particularly their children, the climate has proved most healthy and salubrious. The diseases are but few, and of a very mild type, as compared with other localities. Epidemics occur but seldom, and are light in character, while contagious diseases are scarcely known.

In conclusion, I feel I cannot too strongly recommend to consumptives, or to those predisposed to tubercular disease, a residence on these charming islands, cradled in the Pacific, beneath a tropical sun, yet so tempered by the benign influence of the trade winds, sweeping across the ocean, as to render the climate unsurpassed in mildness and equability, permitting all the benefits possible to be derived from a constant out-door life.—*Proceedings Medical Society, Kings County.*

THE EFFORTS OF CHINA TO SUPPRESS THE OPIUM TRAFFIC.

ONE of the most remarkable chapters in the history of civilization is the persistent efforts of the Chinese Government to prevent the importation and use of opium among its people.

Over a century ago the government recognized the dangers following the use of this drug, and began to legislate against it, pushing the offenders with banishment or strangulation.

The opium was grown in India, and smuggled into China by English ships, encouraged by the English Government, and the sale and demand constantly increased. Year after year the Chinese officials made frantic efforts to check this evil. Opium was contraband, and all who were found smoking or using the "black dirt" (as they contemptuously called it) were punished with death or perpetual servitude. This trade brought an increasing revenue to the English Government, and they determined to force its sale on the Chinese, which was stubbornly resisted for a long time, until finally it culminated in a war (1839), which Mr. Gladstone denounced as one calculated to cover the country with permanent disgrace. The Chinese were disastrous, but nothing definite was gained beyond the forced privilege to bring in opium by the English.

In the meantime the growth of the poppy in China increased in spite of all legislation to the contrary, and the demand increased, nearly doubling in ten years.

In 1857 another war was provoked by England, which was literally the great struggle of a pagan nation to save itself from the curse of opium, which the rapacity of English civilization sought to force upon it, for the mercenary purpose of increasing its Indian treasury.

The Chinese failed, and yielded to the pressure to admit opium at a fixed duty, which they have several times sought to raise, but the English Government has always refused. A new proposal has been made to England this year to increase the duty, and the decision of the government is anxiously watched.

The extent to which opium is used may be realized from the fact that the importations from India for 1876 amounted to over seven millions of pounds; to this may be added over a million more pounds raised in the country.

It is estimated that no less than six millions of people both chew and smoke this drug constantly.

If these figures are correct, we cannot wonder that the Chinese Government are alarmed, and have at last determined upon a new movement for "stamping out" this terrible evil. An edict has been issued forbidding the culture of the poppy after 1879, in any part of the kingdom, and prohibiting all importation after 1880; also an edict has been sent to all the governors and leading generals of the provinces, requiring them to submit plans of laws, which shall become a law, and effectually do away with the use of opium, under pain of death, after a period of three years.

The *denouement* or result of this wonderful struggle will be one of the great events of the century. The sagacity of the Chinese officials in recognizing the fatal effects of the introduction and use of opium, and in persistent opposition, extending over a century, furnishes a lesson to our boasted civilization which we cannot afford to lose.

In this country we are just beginning to realize the necessity of some legislation that shall control the abuse of opium and its compounds, and no one dare deny that the same peril which the Chinese discerned a century ago may not threaten us to-day.

The opening of Parrish Hall, Brooklyn, N. Y., as an asylum for opium cases alone, and the large number of patients already gathered, seeking relief, are significant hints of the presence of a disorder, which, like a malignant disease, will soon destroy the vitality of both community and nation.—*Quar. Jour. of Inebriety.*

ORIGIN OF DIPHTHERIA.

DR. E. M. SNOW says, in his last report as Superintendent of Health, Providence, Rhode Island:

The evidence constantly accumulates in this city, that diphtheria depends for its existence and prevalence upon foul air, arising from local conditions of filth. Though it is inoculable, and in that way contagious, and is, perhaps, to some extent, infectious, there is no evidence that, practically, the disease is propagated by inoculation or contagion or infection. We may expect that diphtheria will continue through the winter, though perhaps with less severity than during the last two months; but it will still continue to search out its victims among those whose constitutions are prepared for it, by breathing foul air and other depressing causes.

The necessity for disinfecting and removing offensive filth of every description, continues as imperative as ever. Too much care cannot be taken in this respect.

The deaths from diphtheria, in each month of the present year, have been as follows:

January	14	July	9
February	13	August	12
March	20	September	39
April	18	October	48
May	31	November	37
June	21		
Total, 11 months			203

The disease will number nearly 300 victims in Providence, during the year 1877.

MONEY VALUE OF LIVES.

BASING it upon the agricultural classes of Norfolk, Dr. Farr estimated that an infant at birth was worth twelve dollars and a half, in its prospective labor. Five years later his value as a productive agent was one hundred and thirty dollars, and five years later it has more than doubled At the age of twenty-five he has attained the maximum value, six hundred and fifteen dollars a year. At fifty it is reduced down to three hundred and forty-five dollars, and so on down to seventy, when the value is only two dollars and a half a year. Should he live to eighty, his value is one hundred and two dollars less than nothing.

THE PLETHYSMOGRAPH.

M. Mosso, of Turin, has invented an instrument for observing the variations in the circulation of blood in the arms, under the influence of natural or artificial causes. The entrance of a person into the room causes a diminution of the fore-arm, which may vary between four and fifteen cubic centimeters, the blood quitting the arm and mounting to the head. Thought and cerebral activity seem to be in proportion to the contraction of the vessels of the fore-arm. During sleep, dreams cause a depression in the circulation of the arm. Just before waking there is a like depression. The experiments confirm the theory of Durham, Hammond, and Ehrmann, that the brain receives less blood during sleep than when awake.

CULTIVATION OF MEDICINAL PLANTS AT HITCHIN, ENGLAND.

By E. M. HOLMES, F. L. S.

Curator of the Museum of the Pharmaceutical Society.

The neighborhood of Hitchin is one which is interesting on many accounts. The spot which Dickens has immortalized as Tom Tiddler's Ground is within a few miles of the town. The geologist will notice here the outcrop of the London basin, and the antiquary will meet with much to examine in the way of flint implements and other ancient relics. The botanist will find in the spring abundance of the rare *Anemone Pulsatilla* within a few miles of the town, and cannot fail to admire the row of ancient box trees, with trunks fully a foot in diameter, and about twenty feet high, which are conspicious by the roadside near the center of the town. These probably are the largest and oldest box trees in England. A curious feature in this district is the straw plaiting, which is carried on almost mechanically by women, even as they walk along the streets or through the fields to their work; their eyes keenly observant of all around them, and their talk seasoned with remarks, often more shrewd than polite, upon the passers-by. On a Tuesday, which is the market day, the town often presents a busy scene, sometimes as much as £1,000 worth of straw plait changing hands in one day. This is chiefly bought up by middlemen from Luton and Dunstable, who supply the peasantry with prepared straws for the purpose. For the pharmaceutist, however, the chief attraction of course lies in the fields of medicinal plants which are scattered all around the town.

The plant which is most extensively grown in the neighborhood of Hitchin is the lavender (*Lavandula vera*, D. C.). The cultivation of this plant was commenced in 1823 by Mr. Perks, and at the present time is carried on by his son, and also by Mr. Ransom, who commenced its cultivation in 1847. It is to these two gentlemen that our readers are indebted for most of the interesting facts which are embodied in this paper. Both these gentlemen have received medals for the excellence of their productions, Mr. Perks for oil of lavender, and Mr. Ransom for essential oils and pharmaceutical products generally.

The crop at present grown is much affected by the presence of a disease which attack the plants just as they are beginning to flower, and causes them to wither away by degrees. This disease occurs not only at Hitchin, but also at Mitcham (in fact, it appeared at Mitcham before it was known at Hitchin), and, so far as I have been able to ascertain, at all the localities in which lavender is grown. To such an extent has it occurred at Market Deeping in Lincolnshire that Mr. Holland, who formerly cultivated lavender there, has now ceased to grow it. The disease prevailed to a consider-

able extent this year, and on this account and by reason of the smallness of the crop, the price of oil of lavender will probably be unusually high.

The history of the cultivation of lavender reveals some curious facts which may perhaps throw a little light upon the probable cause of this disease. Formerly the plant was propagated by slips taken from the branches, for the plant does not ripen seed. Whether or not it has lost the property of ripening seed through cultivation, as has been the case with the rhubarb plant at Banbury, I have not been able to ascertain.

In the winter of 1860, owing to a very severe frost, nearly all the lavender plants were killed, and to secure a crop for the next year, instead of taking slips, the roots were parted, and from that time to the present the same mode of propagation has been continued. About this time (1860) the disease first appeared.

Plants which are obtained by parting the roots for one year old plants are much more vigorous and less liable to the disease than those obtained by dividing the roots of those of two years' growth.

The first appearance of the disease is indicated by the leaves of one or more branches drooping and withering away; and the remainder of the plant becomes affected by degrees. When the root of a diseased plant is pulled up, the rootlets appear fewer in number than in a healthy plant, and the woody portion from which the rootlets spring is often covered with a filamentous mycelium, but sometimes only presents a dark color and wet appearance internally.

The appearance of the disease just as the plant has begun to flower, and the fact that the plants now come to maturity in about three years, whereas they used to last five or six years, seems to indicate that the tendency to produce flower and foliage has been stimulated to a greater degree and caused a greater demand upon the root than it is able to meet. The vitality of the plant has probably been lowered by years of reproduction from the stem instead of in the way that nature has appointed, viz., by the seeds. The method of propagating at present adopted is certainly one that is very likely to continue the disease, since it may be latent in the divided root of apparently healthy plants. That the disease is not likely to be owing to difference in soil is shown by the fact that fresh soil or otherwise, manure or no manure, make no difference in its appearance.

The method of cultivation is as follows:

The harvest of lavender flowers is rarely over until the middle of September, so that it is not possible to get the ground cleared and ready for fresh plants before the end of October or beginning of November. The ground which is to be planted is generally manured beforehand with thirty to forty-five tons of stable manure per acre, but manure is not applied afterwards until fresh planting takes place. The roots of the old plants are parted sometimes from two, but preferably from one year old plants, and the sets dibbled in rows about eighteen inches apart. The young plants make a start in growth in March, if the weather be mild with gentle showers, and increase considerably in size in April and May, so that the tufts become on an average about a foot in diameter. If, however, there occur heavy rains so that the leaves are much splashed with soil, the growth is somewhat stopped. In hollows, or where the damp is liable to remain, the young flowering stems, if there be frost in May, are frequently nipped, and the plant either dies or does not send up fresh flower stalks until the end of June, making the harvest a late one. Black frosts do not, however injure the plants.

The sets, if made by parting the roots, flower the first year; if, however, slips from the branches are taken, they are not allowed to flower the first year lest the young plants should be weakened thereby, but the flower shoots are clipped down close to the stem.

In the second year every alternate plant is removed in the autumn and planted elsewhere, leaving the others one yard apart. The second year plants attain a diameter of about 15—18 inches, and in the third year the tufts are from 2 to 2½ feet across.

Shade has a pernicious effect upon the plant; under the shadow of trees they become starved and produce scarcely any flowers. The growth of other plants between the rows also injures the crop. Weeds to have to be kept down. In order to prevent injury to the roots of the lavender plants while removing the weeds, Mr. Perks uses an instrument of sufficient width to pass easily between the rows, and composed of a number of hoe-like blades, the upper portion of the instrument being like a plough. By means of this apparatus he is enabled to cut off the weeds just below the surface of the ground, and at the same time to avoid injuring the tender roots of the lavender. The plants grow best and produce most blossom when they have plenty of room and sunshine. If too crowded, flowers are only produced from the center of the tufts and not from the sides where the plants come in contact with each other.

The weather has considerable influence upon the yield of essential oil. If the days are bright and sunshiny during June and July, the yield will be a good one, but if wet and dull very often not half the average will be obtained. Mr. Perks informs me that a 200 gallon still will yield about 1½ lb. of essential oil in a good season, but in a bad one, as in the present year, barely 12 ounces.

The time at which the flowers are gathered also appears to modify the yield, Mr. Ransom giving as the result of his experience that the product is very much reduced if gathered after the first week in September, the largest quantity of oil being obtained about the middle of August.

In collecting the harvest, which usually begins about the first week in August, the flower-stalks of one plant are grasped as far as may be with one hand and a sickle is used with the other. They are (by Mr. Ransom) then packed in eight-buahel sacks, and carried direct to the still, about fourteen sacks going to a 1,000 gallon still; or they are tied up in bundles weighing about twenty-two pounds (by Mr. Perks) and as much as possible of the stalks afterwards cut off and the still then filled up with flowers. The distillation is commenced at four or five o'clock in the morning, and the still is filled four times a day, the men leaving work at 10 P.M.

The distillation of each quantity takes about two and a half hours, the largest portion of oil coming over during the first hour and a half. A considerable time is of course taken up in filling and emptying the still. The flowers are trodden down in the still by boys, who for the first day or two are often severely stung by the bees which cling most pertinaciously to the blossoms, and appear to be quite intoxicated with the honey of the lavender, especially towards the end of the season.*

The water which comes over with the oil during the first hour, being slightly impregnated with oil, is returned to the still, but that which comes over afterwards is allowed to run away.

The oil which comes over after the first hour and a half is either redistilled or sold as inferior quality. The refuse when removed from the still is thrown into heaps, and when decayed is returned to the lavender fields. In a good year the lavender yields from four to six Winchester quarts of essential oil per acre, and as about fifty-three acres altogether are cultivated the average yield of oil for the whole of Hitchin is about two hundred and forty Winchester quarts per year.

The quality of the oil is said to be affected by the soil and situation in which it grows, so much so that Mr. Ransom informs me he can distinguish the oil obtained from different fields by the odor alone. The oil is improved by keeping, up to three years, after which it begins to deteriorate unless mixed with spirit.

Redistillation also improves the quality of the oil, but unless conducted by steam heat the loss sustained is not compensated for by increase in commercial value, the loss being nearly one pound in the gallon.

The stems are not distilled, as the oil obtained from them is of very inferior quality, and is so small in quantity that it does not pay for labor and fuel.

The lavender grown by Mr. Ransom is distilled by steam heat, by which any tendency to an empyreumatic odor is avoided.

Belladonna.—About eight acres are grown of this plant, from which extract is made on the spot. The plants are raised from seed, and being perennial are grown on the same ground from seven to ten years, when they are replaced by fresh ones.

The crop is not cut the first year, but in the middle of June of the second year, and again at the end of September. The plants usually attain the height of rather more than two feet, but if heavily manured they will grow much larger. It is found, however, that in plants which show large leaves and grow rapidly the medicinal properties are less powerful in proportion, even the odor of the plant being weaker.

This is somewhat analogous to what is known of the cinchona trees, in which, as a rule, the smaller the leaves the larger the yield of alkaloid. About five pounds of extract are obtained from one cwt. of herb.

Hemlock.—Very little hemlock is grown, the wild plant being preferred. It is said to be plentiful in the neighborhood, nearly twenty tons of it being sometimes made into extract in one year by Mr. Ransom. From four to six pounds of extract are obtained from one cwt. of herb.

Squirting Cucumber.—Only two or three acres of this plant are grown every year, there being comparatively little demand for elaterium in this country. The plants are earthed up in winter like celery and require plenty of manure applied annually. The yield of elaterium depends much upon the weather, very little being obtained in a wet season. If the month of August is fine and dry, the yield is not only larger but of superior quality. The drug as prepared by Mr. Ransom is of a fine ash green color and comparatively sweet odor. This result is obtained by pouring off the supernatant liquor as soon as possible after the elaterium has deposited. If this be not done, fermentation is soon set up and the product depreciated in quality. Although Mr. Ransom probably grows more than any one else in England, the demand is so small that some wholesale houses have often not purchased more than two ounces in twelve months. That which is exported goes chiefly to Russia.

Henbane.—About five or six acres of the biennial plant are grown on the average; but the quantity varies very much, being almost a total failure in some years. Mr. Ransom's experience corresponds with that of Mr. Usher, of Banbury, as regards the uncertainty attending the appearance of the plant from the seed. Indeed in one of the fields at Hitchin, in which lavender plants two years old were in blossom at the time of my visit, only the biennial henbane had come up, which had been sown before the lavender was planted there.

A small quantity of marshmallow is also grown by the riverside, where it does well.

The above are, I believe, the leading medicinal plants which are grown in the neighborhood of Hitchin.

Mr. Ransom produces at his extensive laboratory a very large number of extracts, essential oils and liquors, and many of these in very large quantity, using as much as 40 tons of dandelion root per annum. Some of the extracts are such as are rarely asked for in retail shops, but for which there must be local demands. Among these were noticeable the extracts of sarsaparilla, *Actæa racemosa*, *Chelidonium majus*, *Datura Tatula*, *Saponaria officinalis*, wormwood (*Artemisia Absinthium*), angelica (*Archangelica officinalis*), centaury (*Erythræa Centaurium*), pulsatilla (*Anemone Pulsatilla*), blessed thistle (*Carduus benedictus*), walnut (*Juglans regia*), white horehound (*Marrubium vulgare*), buckbean (*Menyanthes trifoliata*), St. Ignatius' bean (*Strychnos amara*), senega, and the alcoholic extract of belladonna and ipecacuanha. The extract of Ignatius' bean is used for epilepsy and goes chiefly to Australia and China. To give an idea of the extent to which some of these uncommon extracts are used, it may be stated that as much as thirty or forty pounds of extract of *Ignatia amara* is turned out annually. All these extracts are made in steam evaporating pans, the juice being in many cases expressed from the plants or roots under a hydraulic pressure of 300 tons.

A prominent feature in the laboratory is the apparatus for making scammony resin from the root. This is obtained by percolating hot spirit through the powdered root. As expression of the root after percolation would involve considerable loss, and the last portion of spirit has to be displaced with water, considerable trouble has to be taken in freeing the resin from aqueous extract. In dissolving the resin of scammony of commerce in ether a small amount of insoluble matter will often be found, which is probably matter of this kind. Economy of fuel is provided for as far as possible by causing the hot water from the steam pans, etc., to pass into a large tank from which it is pumped by the engine into the boiler, etc., as required. The latest improvements have been adopted, even to the use of a patent for preventing the escape of steam while allowing the hot water to escape.

In conclusion, one word of caution is necessary to those who may feel inclined to visit Hitchin. The lavender fields are a sight worth seeing when in full flower; the handsome red admiral (*Vanessa atalanta*), the tortoiseshell (*V. urticæ*), the gorgeous peacock (*V. Io*), the brimstone (*Gonepteryx rhamni*), and even the clouded yellow butterfly (*Colias edusa*), as well as many commoner species, are to be seen in great force hovering over the flowers. But let not the visitor be tempted to chase the lovely insects, for most formidable and by no means beautiful is the harvest insect, which seems to have an equal predilection for lavender fields and manifests a peculiar desire to leave an impressive reminiscence with all who venture among the blossoms, and no one who has made its acquaintance there will ever forget Hitchin.—*Phar. Jour. and Trans.*

STREET DUST.

By HENRY G. DEBRUNNER, Chemist.

It has lately been stated in several scientific periodicals that the dust of the active thoroughfares of Paris, London and other large European cities, contained 35 per cent. of metallic iron, given by the shoes of the horses to the stones, besides from 30 to 40 per cent. of good glue from the hoofs. These data were by no means represented as exceptional ones, it being stated that they did not vary much for a period of over two months. The glue as well as the iron were intended to be recovered, the former very probably by extraction of the dust with boiling water, the latter by reduction of the resulting insoluble residue, now containing over 50 per cent. of metallic iron, in small blast-furnaces. Thinking that the dust of the most active thoroughfares of our smoky city should fully equal any "European" dust, at least in regard to the percentage of iron, I collected samples from different parts of the city, and subjected them to analysis, with the following results:

Dust from Thirtieth and Smallman streets, Pittsburg. Sample taken Sept. 22, 1877.

Moisture,	1.2050 per cent.	
Carbonic acid,	1.0400	Total loss on ignition, 48·8407 per cent.
Gluten,	0.9210	
Bitumen and other volatile organic matter,	17.5720	
Fixed carbon,	26.1027	
Silicic acid,	30.4314	
Phosphoric acid,	2.1982	
Sulphuric acid,	0.9633	
Ferric oxide,	12.2203	
Alumina,	2.3132	Ash, 53.1593 per cent.
Manganic oxide,	0.0625	
Lime,	3.2174	
Magnesia,	1.4720	
Alkali chlorides,	0.2330	
Ammonia,	trace	
Loss,	0.0480	
	100.0000	

Metallic iron=8.55 per cent.—in HCl extract 6.74 per cent. Gluten=0.921 per cent. in aqueous extract. Soluble in water 1.10 per cent. (leaving 0.2 per cent. ash). Ashes on ignition, subsequent to extraction with hydrochloric acid, 41.5 per cent.—soluble SiO =0.31 per cent.

Ashes from samples of dust from different parts of said streets amounted to 50.25, 50.91, 51.92, 49.94, 53.16, 52.25 per cent.

Samples of dust taken from center of crossing of said streets:

Moisture,	1.20 per cent.
Volatile organic matter,	18.65
Fixed carbon,	27.90
Ash,	52.25
	100.00

This dust was of a deep black color. On ignition, combustible hydrocarbons—bitumen—originating from coal, were liberated, of which said dust contained at least from 30 to 35 per cent. Previous to analysis the dust was sifted through a moderately fine sieve.

As to the estimation of gluten I used the following method: 100 grams of dust were extracted with strong boiling alcohol, to which a few drops of caustic soda solution had been added to render it slightly alkaline. The dust thus extracted was then dried on a water bath to expel the alcohol, and boiled with 500 cc. of distilled water. The alcoholic extract contained a brown coloring matter, and decomposed organic substances in small quantity, for the extraction of which I had applied this treatment with hot slightly alkaline alcohol. The subsequent aqueous extract contained dissolved gluten, which was weighed after evaporation to dryness on a water-bath. It was finally ignited, and the weight of the ashes deducted from the one previously obtained.

In the following analyses the treatment of dust with alcohol was omitted; the glue was estimated on evaporation of the aqueous extract to dryness in a tared platinum dish, and deduction of the ashes on subsequent ignition.

	1.	2.	3.	4.	5.
Moisture,	0.927	1.179	0.765	1.512	1.534 per cent.
Volatile organic matter,	9.928	5.734	6.152	2.492	3.143
Fixed carbon	6.847	10.295	13.874	7.594	20.108
Ash,	82.253	82.792	79.249	88.472	75.215
	100.	100.	100.	100.	100.
Iron,	6.84	9.69	7.41	5.130	5.71
Glue,	6.214	0.602	1.272	3.521	4.731

No. 1 was dust from the horse-track on Penn street, near Union Depot, and was of grey color. No. 2 was from Smallman and 31st streets, and also contained coal, recognizable by the liberation of combustible hydrocarbons—bitumen—on heating.* No. 3 was taken from main road of Black Diamond Steel Works, and was of a dark-grey color and contained coal. No. 4 was dust from 32d and Liberty streets, free from coal, and of light grey color. No. 5 was collected from Penn, between 30th and 31st streets. Some dust and débris was taken from a road near East Liberty Stock-yards, Pittsburg, and without being sifted yielded glue, 16.242 and iron, 5.722 per cent.

The abrasions from rails of the horse-track on Penn street form a grey, almost metallic, sandy powder, containing 32.12 per cent. of metallic iron partially non-oxidized, while in the other samples this metal existed in form of sesquioxide. The limited quantity of this material, although nearly as rich in iron as poor ore, prevents utilization.

As to the quality of the glue, it may be stated that it is very impure and has a rather bad odor. It however possesses all the characteristic properties of glue; its solution forms a jelly when cooled; tannin, alum and alcohol precipitate it flocculently, while it has at the same time adhesive power to a certain extent. Iron as well as glutinous matter, however, are present in too small quantity to be of any technical significance.

Although badly disappointed, I am now fully convinced that these new branches of glue and iron manufacture "won't do" for Pittsburg, while perhaps at the same time my analyses of street dirt may be of interest to some of the readers.—*American Jour. of Pharmacy.*

Black Diamond Steel Works, Pittsburg, Nov. 17, 1877.

* I am aware of the fact that glue, besides leaving carbonaceous residue, also forms combustible gases on ignition, requiring, however, a higher temperature than necessary for the liberation of bitumen from coal.

TESTS FOR OIL OF ALMONDS.

J. D. BIEBER, manufacturing chemist at Hamburg, communicates the following reagent as a reliable test for this oil: Equal weights of pure concentrated sulphuric acid, red fuming nitric acid and water are mixed, and the mixture allowed to cool. The test is applied by mixing five parts of the oil with one part of the acid liquid, when *almond oil* will give a yellowish-white liniment; *oil of peach kernels* assumes red color of peach blossoms, turning to dark orange; *benne oil* turns pale yellowish-red, then dirty orange red; *poppy and walnut oils* yield a somewhat whiter liniment than almond oil. This test permits the detection of 5 per cent. of peach kernel and benne oil.

Mixed with pure nitric acid, spec. gr. 1.40, *almond oil* yields a pale yellowish liniment: *peach kernel oil* a red, *benne oil* a yellowish-green, afterwards reddish, and *poppy* and *walnut oils* a white mixture.

It was found that the oil expressed, cold or warm, from fresh almonds or such as had been kept up to ten years, gave the same reaction. Most of the commercial oil was found to adulterated with the oil of either peach kernels or benne seed.—*Apoth. Zeit.*

PHOSPHIDE OF TIN,

Is at present an article of commerce, and is technically employed in the place of phosphide of copper for the preparation of phosphor-bronze. S. Natanson and G. Vortman, have prepared it, 1, by heating a mixture of 3 p. glacial phosphoric acid with 1 p. charcoal and 6 p. tin; 2, by fusing glacial phosphoric acid with tin; 3, by passing phosphorus vapors over tin fused in a current of hydrogen (Vigier's method, 1861), and 4, by throwing phosphorus upon fused tin (Pelletier and Landgrebe's process, 1829). The products were silvery-white and foliaceous, contained between 96 and 98 per cent. of tin, and were soluble in muriatic acid, with the evolution of phosphoretted hydrogen. If heated with nitric acid for a short time, then just sufficient muriatic acid added to dissolve the stannic acid, and again heated for some time, yellowish scales of a metallic lustre are left, which contain 75 per cent. of tin, and, when boiled with caustic potassa, yield a brown-yellow solution and silvery scales, containing 79.53 per cent. tin. The formula SnP requires 78.89 per cent.—*Ber. Deutsch. Chem. Ges.*

SYRUP OF ORANGE PEEL.

A. MARTIN obtains an excellent product by drying the orange peel, preferably the kind known as Curaçao, occurring in bands, by enclosing it in a tinned iron vessel containing a bottle half filled with burnt lime, and the cover which is luted with flour paste and paper. After remaining for eight days in this desiccator the orange peel is dry enough, without having lost any of its aromatic principles, to be easily reduced to powder; this is then exhausted by percolation with water at the ordinary temperature, and the infusion heated to about 70° C. (158° F.) to coagulate the albumen, filtered and converted into syrup in the usual manner.

BACTERIA.

AT a recent meeting of the Royal Society, Sir Joseph Hooker in the chair, a paper was read by Dr. J. Burdon Sanderson, entitled, "Remarks on the Attributes of the Germinal Particles of Bacteria, in reply to Professor Tyndall." Professor Tyndall's paper, to which this was a reply, was read at the close of the last session of the society, and in it he had made reference to a report of a lecture by Dr. Burdon Sanderson before the medical officers of health. The object of the present paper was first to reply to the reasoning embodied in Professor Tyndall's last communication, and next to corroborate certain statements previously made, to which the Professor had taken exception in the memoir published in the 166th volume of the "Philosophical Transactions." Dr. Sanderson believes that the difference between them relates chiefly to two subjects, viz., the sense in which the doctor has employed the words, "germ" and "structure," and the extent of the knowledge at present possessed by physiologists as to the structure and attributes of the germinal particles of bacteria. In entering on the discussion of the sense in which the word "germ" had been used, Pasteur's Memoir "Sur les Corps Organisés qui existent dans l'Atmosphére" was quoted, embodying the idea of a germ which continued to be entertained by informed persons up to 1870, and by many up to the present moment. It was affirmed that the "corpuscules organisés" were, if they had any relation to the bacteria, not germs in Professor Tyndall's sense, but finished organisms and yet it was of these that Pasteur said that it was mathematically proved that they were the originators of the organisms which are developed in albuminous liquids containing sugar when exposed to the atmosphere. The next point dwelt on was the sense in which Dr. Sanderson had used the word "structure" When he said that the bacteria germ was endowed with structure he meant in the molecular sense, but not in the anatomical sense; and what he asserted of the germinal particles of bacteria was that no evidence exists of their being endowed with that particular texture which forms the subject of science of histology. The biologist cannot recognize ultra-microscopical structure excepting as matter of inference from observation—*i. e.* from observing either that other organisms, which there is reason to regard as similar to the object in respect of which structure is inferred, actually possess visible structure, or that the object can be seen to possess structure at a later period of its existence. In all embryonal organs we admit the existence of structure before it can be seen, because in the course of development we observe its gradual emergence. Dr. Sanderson's views were illustrated by reference to his paper on the origin of bacteria, published in 1871. The experiments made at that time brought to light the then new fact, now become old by familiarity, that all liquids, even when absolutely free from visible particles, and all moist surfaces, are contaminated and exhibit a power of communicating their contamination to other liquids. As regards water and aqueous media in general, he insisted on the "particulate" nature of the contaminating agent, at the same time pointing out that the particles in question were ultra-microscopical, and consequently that their existence was matter of inference rather than of direct observation. Dr. Tyndall has demonstrated that the ordinary air also contains germinal particles of ultra-microscopical minuteness. That such particles exist there can be no question, but of their size, structural attributes, or development we know nothing. Dr. Burdon Sanderson continued:—Wherever those chemical processes go on, which we collectively designate as life, we are in the habit of assuming the existence of anatomical structure. The two things, however, although concomitant, are not the same, for while anatomical structure cannot come into existence without the simultaneous or antecedent existence of the molecular structure which we recognize as living, the proof is at present wanting that the vital molecular structure may not precede the anatomical. At the same time it must be carefully borne in mind that there is no evidence of the contrary. The inadequacy of the proofs that have hitherto been brought forward in favor of the hypothesis that the germs of bacteria, for example, are organized structures does not render it the less probable that they are so. The second part of the paper consisted of reference to the work of Continental experimenters to show that statements which Professor Tyndall, in 1876, characterized as incautious, had been two years before confirmed by experimenters of acknowledged competence.

SILKWORMS.

THE common silkworm is a native of India or China, though reared in many other parts of the world. The perfect insect is an inch or two in length, the female rather longer than the male, the wings meeting like the sides of a roof. the color whitish, with a broad pale-brown bar across the upper wings. The females generally die very soon after they have laid their eggs, and the males do not survive much longer. The eggs are numerous, about the size of a pin's head, not attached together, but fastened to the surface on which they are laid by a gummy substance, which, when dry, becomes silky. The eggs are laid in the end of summer, and are hatched in the beginning of the next summer.

THE EAST INDIA SILK WORM.

The caterpillar is at first very small, not more than a quarter of an inch in length, but rapidly increases in size, till, when full grown, it is nearly three inches long. It is of a yellowish gray color, with a large head; its skin is changed four or five times during the growth of the caterpillar, though they frequently die during these changes. A very rapid increase of size takes place while the new skin is still soft. The natural food of the silkworm is the leaves of the white mulberry, but it will also feed on the leaves of some other plants, as the black mulberry and the lettuce; however, when fed on these latter articles, it produces silk of inferior quality. The spinning apparatus is placed near the mouth and connected with the silk bags, which are long, slender, convoluted organs, containing a liquid gum. Every thread of silk is made up of two strands, being equally derived from the two silk-producing organs of the caterpillar.

The silkworm lives exposed in the wild state, but none of the Chinese or European worms are allowed to incur the risks of life in the open air. One hundred newly-hatched silkworms weigh one grain; after the first month, fifteen; after the second, ninety-four; after the third, 400; after the fourth, 4,628; and at full size 9,500 grains. Each consumes an ounce of mulberry leaves during these stages, nearly 60,000 times its primitive weight, while its length increases from one to forty lines during the same period. By calculation the product of an ounce of eggs eats upward of 1,200 pounds of leaves, and should furnish 120 pounds of cocoons.

When about to spin its cocoon, or oblong case, in which the silkworm lies in its chrysalis state, the worm ceases to eat, and first produces the loose, rough fibre, which forms the outer part of the cocoon, afterwards the more closely disposed and valuable fibre of its interior. In this process the position of the hinder part of the body is little changed, but the head and front of the body are moved up and down and crossing to every side, entirely surrounding the body with fine silk, as a protection against wind and cold. The cocoon when finished is much shorter than the body, which, however, being bent, is completely inclosed in it. The cocoon is about the size of a pigeon's egg, one to one and a half inches long and of a bright yellow color

The time of the silkworm's life in the caterpillar state is generally from six to eight weeks; about five days are occupied in the spinning of the cocoon, after which about two or three weeks elapse before the cocoon bursts and the perfect insect comes forth. The natural bursting of the cocoon is, however, injurious to the silk, and the silkworm rearer prevents it by throwing all the cocoons into boiling water, except those which he intends keeping for the future increase of his stock. These he selects with care, so he may have an equal number of male and female insects, the females being known, even in the chrysalis state, by their larger size. Other operators adopt the plan of steaming the cocoons over boiling water, when the glue is softened so as to allow the unwinding of the silk, and permits the moth to come forth alive from the interior layer, and deposit the eggs or prepare for a new brood.

The length of reeled silk obtained from a single cocoon varies from 300 to 600 yards, and it has been estimated that twelve pounds of cocoons, the produce of the labors of 2,000 to 2,800 worms, who consumed 152 pounds of mulberry leaves, give one pound of reeled silk, which may be converted into sixteen yards of silk fabric. A pound of silk has been raised from 1,600 worms. One good-sized mulberry tree will, on an average, feed as many silkworms as would produce annually seven pounds of silk. In China the cultivation of silk was begun 2600 B. C. It forms a great branch of industry in Italy, Turkey, Greece, France, Spain. as well as in many other countries, while laudable efforts have been made to cultivate silkworms both in England and America. Silkworms are very tender, and liable to perish from slight changes of temperature and dampness, from foul air and improper or insufficient food.—*American Cultivator.*

GERMS IN DISEASE.

ACCORDING to observations reported to the French Academy, MM. Pasteur and Joubert show that the terrible animal disease which is known as *charbon or sang de rate* (carbuncular gangrene), is caused by microscopic bacteridia, which were first observed by Dr. Davaigne, in 1850. It may, therefore, be classed with trichinosis and the itch, as a parasitic disorder. Vibrios, bacteria and bacteridia, are all found under two essentially distinct forms; either in translucent threads of variable length, multiplying rapidly by division, or in groups of little brilliant corpuscles formed in the interior of the threads, which separate from the parent, and constitute an apparently inert mass of points, from which countless legions of filiform individuals may come, having the same twofold methods of reproduction. The threads may be killed by drying, or by a heat much below that of boiling water. The germs, when dry, withstand temperatures from 120°. to 130° C., or, 248° to 266° F.

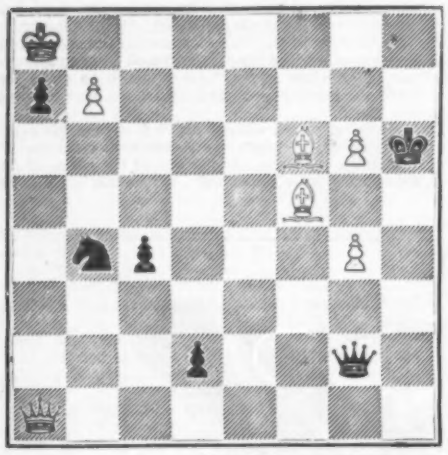
NEW IDEA ABOUT WATER.—M. L. Maiche has been led by a number of experiments to conclude that water is simply hydrogen + electricity, or oxygen—electricity. Or, in other terms, normal hydrogen, if electrized, becomes water, while normal oxygen, diselectrized, also becomes water; hydrogen, oxygen, and water being one and the same thing, with a different degree of electrization.

SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department, may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 46. "OUR BOYS," BY FRANK NORTON, COUNCIL GROVE.

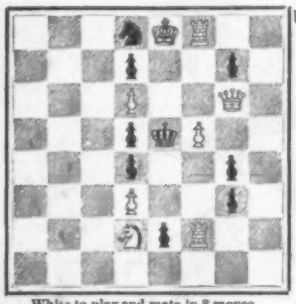
Black.



White.

White to play and mate in three moves.

OUR BOYS.



White to play and mate in 3 moves.
BY HARRY BOARDMAN.

UT little faith can be put in the rumors of youthful prodigies, as their exploits will seldom stand the test of an examination; yet we cannot refrain from expressing our unqualified admiration for early genius that, aside from its phenomenal character, would reflect honor upon older heads.

We are sometimes inclined to believe that Mr. Lowenthal's chess enthusiasm was entirely squelched during his visit to this country by the defeat he received from Paul Morphy, then a diminutive little boy of eleven years of age, and whose brilliant career proves that these early developments of chess skill are not merely precocious freaks of genius, or obtrusive forwardness of the *enfant terrible*, which reaches an early maximum of strength and there remains until the smartness of the boy becomes pitiable stupidity in the overgrown booby.

It is a real pleasure, therefore, when a veteran player or skilled problemist, well versed in the difficulties of perfecting a problem, or mastering the nicities of attack and defence, receives a lesson from such modest unassuming little fellows as Harry Boardman, Simon Fleischman, or Frank Norton.

We have already given a portrait, with biographical sketch, and specimens of the compositions of Harry Boardman, of Melrose, Mass.

Master Fleischman resides in Buffalo, and belongs to a very musical family, both Simon and a younger sister being professional musicians. They have both developed a remarkable aptitude for chess, and have published many excellent problems.

The positions we give in the present issue are taken from a mixed set that was entered in the Centennial Tournament, containing one composition from each of these youthful composers, under the appropriate motto of "Our Boys." The one by Master Fleischman is now correctly published for the first time.

Frank Norton, whose portrait graces our gallery, is now eleven years of age, and has composed several excellent problems, and scored many games against our western players.

His father, Mr. D. P. Norton, is a well known player who has been residing many years in Des Moines; the family having recently migrated *west*, we find their advent thus chronicled in the Council Grove *Kansas Democrat*, of July 19.

"Last Monday a Mr. Norton and family arrived at this place from Iowa, and camped on the East side of the Neosho until they could procure a farm. Among the family was a ten-year old boy that made some pretensions to playing chess. Tuesday morning he was sauntering up street, and in passing Dr. Dill's office espied the Dr.'s chessmen and board. He walked in and wanted to play a game. The Dr. replied that he did not play with babies. Then he thought he would see if the little chap knew anything about chess and told him to place the men in position. This was done all right, and then the Dr. played him a game, giving him the advantage of a queen. Ten-year old won, and three or four even games were played, when the Dr. found out the "baby" could play but he couldn't. He then accompanied the boy to Bradley & Nicholson's office, where he "cleaned out" everything at an even game. He played eleven games on Tuesday morning without the loss of one. He is a bright-looking little fellow, very quiet—hardly ever says a word while playing—and keeps his eyes on the game all the while. If he keeps on he will make a noted chess player at no distant day.

About a year ago Mr Norton attempted to give his little boy the odds of Queen's Rook, with the following result:—

D. P. NORTON.	FRANK.
1. P to K 4	1. P to K 4
2. Kt to K B 3	2. Kt to Q B 3
3. B to B 4	3. Kt to K B 3
4. Kt to Kt 5	4. P to Q 4
5. P x P	5. Kt to Q R 4
6. B to Kt 5 ch	6. P to Q B 3
7. P x P	7. P x P
8. B to K 2	8. P to K R 3
9. Kt to K B 3	9. P to K 5
10. Kt to K 5	10. Q to Q 5
11. P to K B 4	11. B to Q B 4
12. R to B sq	12. Q to Q 3
13. P to Q B 3	13. Kt to Kt 3
14. P to Q Kt 4	14. B to Kt 3
15. Q to R 4	15. Kt to Q sq
16. B to R 3	16. Castles
17. P to Q Kt 5	17. B to Q B 4
18. B x B	18. Q x B
19. P x P	19. Kt x P
20. Kt x Kt	20. B to Q 2
21. B to Kt 5	21. K R to Q B sq
22. Kt to Q 4	22. B x B
23. Kt x B	23. Q to B 3
24. Q to R 5	24. K R to Q Kt sq
25. K Kt to Q R 3	25. R to Kt sq
26. K to K 2	26. Q R to Kt sq
27. P to Q B 4	27. P to K 6 !
28. R to B 3	28. R x Kt
29. Kt x R	29. Q x P ch
30. K x P	30. Kt to Kt 5 mate

FRANK NORTON.

HARWITZ—KLING.

Mr. Harwitz, in his *British Chess Review*, endorses the sentiments contained in the following poetical tribute to Kling:

"Who spend their time in torturing the men,
With mates in fifty upward down to ten.
Theirs, strange positions which true chess ignores,
Or strange conditions which true chess deplores;
Problems in form of sword or crooked staff,
Eggs, lions, comets, and the appropriate calf.
When to each monster they existence give,
They rush to show him while he's strength to live.
For sake of peace and brevity, you smile,
As if approving, though you're bored the while.
No hope, for when this monster's laid asleep
Another rises the dull watch to keep.
But some composers blend with natural grace
A work in which the well trained mind we trace:
No piece or pawn superfluous out of place;
The mate in five, descending down to two—
Ingenious, subtle, unexpected, new.
Respect their skill, their names 'twere long to sing,
But one we give as type—ingenious Kling."

The St. Louis *Democrat* not only approves of our objections to self mates, but notifies composers that they will receive no more such contributions. This is cruel and hard upon the fraternity, and we take pity on them and will receive all such favors; in fact we depend largely upon them for fuel to keep our office warm, and now that the cold winter is setting in our fires must be lighted, and we trust suicidists will remember the fact and send large contributions, with many variations, and written out on much paper.

CHESS TROPHIES.

A VALUED correspondent suggests that, as there seems to be a commendable antipathy among some of our leading problemists against receiving money prizes, that it would be an interesting feature of our Association Tourney to present appropriate gold, silver and bronze medals as souvenirs to the winners of the three highest prizes, and that subscriptions be received for that purpose. We heartily approve of the plan, and subscribe five dollars to the object, trusting that our editorial brethren will further the plan.

Dr. C. C. Moore, who adds five dollars, and volunteers to attend to the preparing of designs, will receive subscriptions.

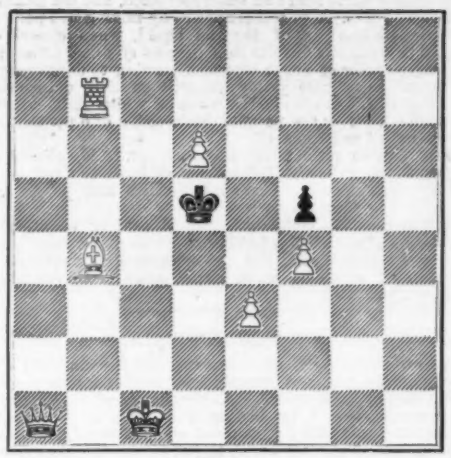
SELF MATES AND CONDITIONAL PROBLEMS.

J. LOWENTHAL, the eminent player and critic, has well said that:

"Suicidal and conditional problems, and those in which the number of moves might have occupied the Sultan all the thousand and one nights with as many days in addition, are much admired—by their respective composers—but by others are laid aside with a despairing yawn. These ponderous trifles must give way to the elegant, the original and the practically useful."

PROBLEM No. 47. "OUR BOYS," BY SIMON FLEISCHMAN, BUFFALO.

Black.



White.

White to play and mate in two moves.

SOLUTIONS TO PROBLEMS.

No. 39.—BY C. A. GILBERG.

White to play.

1. Kt to B 6 ch — 1. Kt x Kt
2. Q x P mate

Self mate.

1. Kt to B 2 ch — 1. R x Kt
2. Q x P ch — 2. Kt x Q mate

Black to play.

1. Kt x Q ch — 1. B x Kt
2. Kt to Kt 6 mate

Self mate.

1. Q to B 7 ch — 1. Kt x Q
2. B x R ch — 2. Q x B mate

No. 40.—BY C. A. GILBERG.

White to play.

1. Q x P ch — 1. Kt x Q
2. Kt x P mate

Self mate.

1. Q x P ch — 1. Kt x Q
2. B to Kt 6 ch — 2. R x B mate

Black to play.

1. P x B ch — 1. Q x P
2. Kt to B 4 mate

Self mate.

1. Kt to B 4 ch — 1. Q x Kt
2. R to Kt 6 ch — 2. B x R mate

No. 41.—BY C. A. GILBERG.

White to play.

1. P Kts ch — 1. K to B 4
2. Kt to R 4 mate

Self mate.

1. R x Q ch — 1. R x R
2. Kt to Q 4 ch — 2. Kt x Kt mate

Black to play.

1. R to Q 3 ch — 1. P x R
2. B to Kt 6 mate

Self mate.

1. R x P ch — 1. R x R
2. Kt to Q 5 ch — 2. Kt x Kt mate

LETTER "O."—BY J. N. BABSON.

1. B x R P — 1. P to Kt 4
2. B to Kt 4 — 2. P x B
3. R to Kt sq — 3. K or P moves
4. R to R sq mate

Chess Spectrum in three moves.

1. R x B (omitted on Q Kt sq) — 1. K x R
2. K to Kt 6 — 2. Any move
3. P to R 8 mate

1. — 1. P x Kt P
2. R to Kt 7 ch — 2. K moves
3. P queens, mating.

MUSIC AND CHESS.

OUR recent biographical notice of the late T. M. Brown, as well as the brief allusion to the gifted young Fleischman children, reminds us that several of our editoria brethren and many eminent writers have remarked upon the fact that there are but few chess players who are not musicians. An eminent phrenologist has said that the same faculties are called into exercise in both sciences. and that the practice of the one is conducive to the improvement of the other. A writer in the *British Chess Review* says: "It is a singular but well authenticated fact, that musicians and chess players have similarly constituted organizations; and it will be found that the same powers are called into play in both characters—memory, concentrativeness, along with other similar qualities, are in the same degree required in both."

A larger number of chess celebrities are to be found in the ranks of the musical profession than among any other class of men.

The long list is headed by the renowned Philidor himself, who was equally famous in the world of music and chess. Walker, the pleasantest of chess writers, says:

"Music springs from the same source, and accordingly chess players and musicians will be ever found intimately mingled. Nixon, Slous, Dizi, Lewis, Bone, Griffin, Latour, Traupenas, and fifty others I could quote, are equally accomplished as musicians and chess players."

Rudolph Willmers, the pianist, received the first prize in the Problem Tourney of our Chess Congress. Fetis, Thalberg, Kling, Maelzel and Staudigl are examples not mentioned by Walker.